Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D. C.

PETITION OF THE NATIONAL ASSOCIATION OF BROADCASTERS FOR INSTITUTION OF RULE MAKING PROCEEDING TO AMEND THE COMMISSION'S RULES WITH RESPECT TO REMOTE CONTROL OPERATION OF VHF TELEVISION BROADCAST STATIONS

NATIONAL ASSOCIATION OF BROADCASTERS

NAB

February 24, 1965

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C.

In the matter of:

Amendment of Part 73 of the Commission's Rules and Regulations with Respect to Remote Control Operation of VHF Television Broadcast Stations	)	Docket No.

PETITION FOR INSTITUTION OF RULE MAKING PROCEEDING TO AMEND THE COMMISSION'S RULES WITH RESPECT TO REMOTE CONTROL OPERATION OF VHF TELEVISION BROADCAST STATIONS

The National Association of Broadcasters respectfully petitions the Commission, pursuant to Section 4(d) of the Administrative Procedure Act and Section 1.401 of the Commission's Rules and Regulations, to institute rule making proceedings looking toward the adoption of the amendments proposed herein or such other amendments that the Commission may determine are necessary in order to accomplish the proposed changes.

I. PRELIMINARY STATEMENT

1. The National Association of Broadcasters is an incorporated, nonprofit association of radio and television broadcasters whose membership as of February 1, 1965 includes 2114 standard broadcast stations, 820 FM broadcast stations, 452 television stations, 4 radio and 3 television networks.

II. BASIS FOR REQUESTED AMENDMENTS

2. On February 1, 1952, the Association filed a request for institution of rule making proceedings to amend the Commission's Rules to authorize remote control of certain standard and FM broadcast stations. On January 27, 1953, at the conclusion of a rule making proceeding, the Commission authorized remote control for certain types of broadcast stations. In rendering this opinion, the Commission stated that the most important consideration was whether the revision in question would result in any degradation of the Commission's technical standards.

3. On February 15, 1956, the Association again filed a request for institution of rule making proceedings to amend the Commission's Rules to extend the previously authorized remote control privileges to include all types of standard and FM broadcast stations, regardless of power or mode of operation. This was authorized by the Commission on September 19, 1957. In granting this authorization the Commission once more reiterated its past position; namely, that the most important consideration was whether the revision in question would result in any degradation of the Commission's technical standards.

4. The instant petition is now concerned with remote control of VHF television stations, a privilege which the Commission has already

extended to UHF television stations by its own action.[1] It is clear from past remote control proceedings that only one issue is really present in any request to extend remote control operation to VHF television stations. This issue, which is critical to a determination of the request, is whether the remote control of VHF television broadcast stations would, in any way, result in a degradation of the Commission's technical standards.

5. This petition, therefore, will address itself to this issue alone. Attached hereto and made part of this petition are four exhibits prepared by or under the direction of George W. Bartlett, Manager of the Engineering Department of this Association, whose qualifications as an engineer are a matter of record with the Commission. Exhibit No. 1 explains in detail the contents of each of the other three exhibits and the significance of each. It is submitted that only one valid conclusion may be drawn from this extensive engineering data.

> THAT THE EXPERIMENTAL DATA CLEARLY DEMONSTRATES THAT REMOTE CONTROL OPERATION MAY BE EXTENDED TO VHF TELEVISION STATIONS WITH ASSURANCE THAT THERE WILL BE NO DEGRADATION OF THE COMMISSION'S TECHNICAL STANDARDS.

1/ May 6, 1963

6. It is significant to note that a survey conducted by the National Association of Broadcasters some years ago in the matter of AM transmitter reliability indicated that the average time lost per year by the stations sampled was three hours and five minutes.2/ A recent survey conducted by the Association concerning television transmitter reliability indicated that the average time lost by the 194 stations sampled was four hours and forty-three minutes (aural). The results are tabulated in Exhibit 2. This not only reports in detail the television station reliability aspect for the years 1957, 1958, 1959, 1960, 1961 and 1962 but also contains other pertinent information relative to station performance and equipment. This survey clearly demonstrates that television transmitting equipment has reached a high state of development.

7. Exhibit 3 is a report of the unattended operation of television broadcast stations owned by the Cyprus Broadcasting Corporation on the Island of Cyprus. It describes in detail the remote control and supervision of high-power VHF-TV television transmitters, a trend which is now spreading across the continent of Europe.

8. Exhibit 4 deals specifically with the problem of remotely controlling VHF-TV transmitters and contains data obtained from experimental

2/ Exhibit 2-NAB Petition for Remote Control of Directional and High Power Stations (February 15, 1956)

remote operation at a group of American television stations. Results of these tests fully confirm the feasibility of remotely controlling VHF-TV transmitters and are a further indication that such operation should be authorized.

9. Section 73.676 of the Commission's Rules presently authorizes the remote control of television transmitters operating on Channels 14-83. The rule states as follows:

REMOTE CONTROL OPERATIONS

(a) Television broadcast stations operating on Channels 14-83 may be authorized to operate by remote control upon a satisfactory showing as to the manner of compliance with the following requirements:

(1) Suitable control circuits shall be installed to:

(i) Turn the transmitter on and off at will.

(ii) Determine the power output of the visual and aural final radio frequency amplifiers or the power delivered to the antenna.

(iii) Adjust the power output of the final radio frequency amplifier to compensate for variations in line voltage.

(iv) Make such adjustments as may be necessary to insure that the characteristics of the transmitted signal comply in all respects with the technical requirements of the rules.

(2) The control point shall be equipped with apparatus suitable for observing the waveform and other pertinent characteristics of the transmitted visual

signal and the percent of modulation of the transmitted aural signal.

(3) The control circuits from the control point to the transmitter shall be so designed and installed that open circuits, short circuits, accidental grounding, or other line faults will not activate the transmitting apparatus and any fault which results in loss of control of the transmitting apparatus will automatically remove power from the transmitting antenna.

(4) The transmitting equipment and control equipment shall be adequately protected against tampering or activation by unauthorized persons.

(b) Where a transmitter is operated by remote control the transmitting apparatus and associated controls shall be checked as often as is necessary to insure proper operation and confirm the accuracy of the transmitter data sent to the control point over the control circuits and in all cases at least once each week it can be demonstrated to the Commission that checks at less frequent intervals are satisfactory.

10. The Association contends that the experimental field tests conducted at the four VHF-TV stations specified in Exhibit 4 conclusively prove that the remote control and metering of VHF-TV transmitters can be successfully accomplished in compliance with Section 73.676 of the Commission's Rules.

III. PROPOSED RULES

11. In accordance with the requirements of Section 1.702, there is set out below the proposed text of the Rules Petitioner believes will accomplish the objectives sought by this request.

SUBPART E - TELEVISION BROADCAST STATIONS

Section 73.676 - Remote Control Operation

Delete from Section 73.676 the phrase, "operating on Channels 14-83".

Add a new section to read as follows:

"Section 73.___ - Remote Control Authorization

"(a) Application to operate a station by remote control may be made as a part of the application for construction permit for a new station.

"(b) Application to operate an authorized station by remote control shall be made on FCC Form 301-A.

"(c) An authorization for remote control will be issued only after a satisfactory showing has been made in regard to the following:

"1) The location of the remote control point(s).

"2) The transmitter is capable of being operated by remote control."

Section 73.681 - Definitions

Add new definition to read as follows:

"Multiplex transmission (Aural)- The term multiplex transmission means the simultaneous transmission of two or more signals within a single channel. Multiplex transmission as applied to television broadcast stations means the transmission of other (aural) signals in addition to the regular broadcast signals."

Add a new section to read as follows:

"Section 73.___ - Multiplex Authorization

"(a) A Television license or permittee may apply for Multiplex Authorization to provide limited types of transmission on a multiplex basis. Permissible use must fall within the following category.

"1) Transmission of signals which are directly related to the operation of Television broadcast stations; for example: remote control telemetering functions associated with authorized STL operation and similar uses.

"(b) Applications for Multiplex Authorization shall be submitted on FCC Form 318."

Add a new section to read as follows:

"Section 73.___ - Multiplex Operation - Engineering Standards.

"(a) Frequency modulation of subcarrier(s) shall be used.

"(b) The instantaneous frequency of the subcarrier(s) shall at all times be within the range - (range to be specified).

"(c) The arithmetic sum of the modulation of the main carrier by the subcarrier(s) shall not exceed 10 per cent.

"(d) The total modulation of the main carrier, including the subcarrier(s), shall meet the requirements of Section 73.687(b) (7).

12. There are various methods of relaying metering information from the transmitter to the remote control point, such as the use of frequencies in the Remote Pickup Broadcast service or the possible utilization of sub-audible tones on the main aural transmitter. The Petitioner believes the use of the multiplex sub-carrier technique in connection with the aural carrier represents the most efficient utilization of spectrum space in that additional frequencies are not then required and the proposed rules reflect this mode of operation.

IV. CONCLUSIONS

13. The Commission has heretofore determined that the remote control operation of Standard, FM, and Television stations operating on Channels 14-83 is in the public interest. In its opinion adopting these rules, the Commission considered and disposed of all objections to remote control operations. The same conclusions are equally applicable to the

instant request. As has been shown, the only issue is a technical one. The reluctance to extending television remote control to include stations operating on TV Channels 2-13 was predicated solely on the lack of technical proof that equipment of this classification could so operate without a degradation of the Commission's technical standards. This lack of evidence has now been remedied. The technical data supplied by this petition clearly demonstrates that the remote control operation of television stations operating on Channels 2-13 is feasible and should be authorized.

14. The adoption of the proposed amendments will bring the Commission's Rules in conformity with the present state of the development of transmitter and remote control equipment.

15. It is respectfully requested that the Commission institute a rule making proceeding looking to the adoption of the proposed amendments to the Commission's Rules, or such other amendments

that the Commission may determine are necessary in order to authorize the remote control of television transmitters operating on VHF-TV Channels 2-13.

Respectfully submitted,

NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, N. W.
Washington, D. C. 20036

By______________________________
Douglas A. Anello

By______________________________
Gordon C. Coffman

COUNSEL

February 24, 1965

AFFIDAVIT

CITY OF WASHINGTON)
) ss:
DISTRICT OF COLUMBIA)

George W. Bartlett, having been duly sworn, deposes and says:

1. That he is the Manager of the Engineering Department of the National Association of Broadcasters with offices at 1771 N Street, N. W., Washington, D. C., and that his qualifications as an engineer are a matter of record with the Federal Communications Commission.

2. That the experimental operation of the Television broadcast stations hereinafter named and the collection of data derived therefrom was upon his initiation and under his direction.

3. That the actual operation of the stations and the logging of the information herein set forth was performed by regularly licensed personnel of the aforesaid stations, and that, upon information and belief, the data furnished by these stations and herein submitted is true and correct.

4. That he has prepared or caused to be prepared under his immediate supervision and direction, except as otherwise stated, the exhibits supporting the instant petition and forming the basis for the conclusions hereinafter set forth.

5. That the foregoing statements and the aforementioned exhibits, which are included herein and form a part of this petition, are true and correct of his knowledge except such portions as are on information and belief, and as to such statements and information, he believes them to be true.

February 24, 1965 ______________________________ George W. Bartlett

Subscribed and sworn to before me this __________ day of ____________________, 1965.

____

Notary Public

EXHIBIT 1

DISCUSSION OF REMOTE CONTROL OPERATION

OF VHF TELEVISION BROADCAST STATIONS

DISCUSSION OF REMOTE CONTROL OPERATION OF VHF-TV BROADCAST STATIONS

Introduction

Relative to this discussion, it is first desired to clarify the use of the term "remote control" as used by the broadcast industry. Remote control is the term which has been generally used in connection with starting, stopping, and actually controlling and metering various functions of the transmitter. There is virtually no limit to the number of functions which may be controlled and metered for a particular transmitter, the only limitation being the number of metering and control circuits associated with the remote control equipment itself.

There are two basic methods of achieving remote control: 1) through the use of metalic circuits; and 2) through the use of RF (radio) circuits between the studio-transmitter. Remote control by metallic circuitry utilizes the conventional overland telephone line system and is primarily dependent upon common-carrier reliability. Remote control by radio employs either a subcarrier multiplex technique for relaying both control and metering information or a combination of multiplex for control and a separate transmitter for relaying metering information. The reliability of a radio remote control system is wholly under the control of the licensee. This petition recognizes both basic methods of achieving remote control.

It should be noted that many TV stations operate with transmitters in remote or isolated locations to which telephone line circuits are unreliable or in many instances unavailable. As in the case of FM remote control, it is the Petitioner's contention that the licensee should have the option of choosing which method of remote control he deems most efficient for his particular operation and should not be restricted to one particular technique. In this regard both types of remote control systems were considered and explored.

In addition to the two system philosophies pursued in this experiment, other aspects of the problem were also explored. Remote control equipment especially designed for a particular station was investigated along with the use of existing "off-the-shelf" systems which were readily available and required only slight modification.

Station KKTV utilized a multiplex system of remote control which was specifically fabricated for that particular station and was extremely sophisticated in circuit concept. This system is not now commercially available to the broadcast industry. Station KFMB-TV utilized commercially available equipment which is presently used to remotely control FM transmitters employing the multiplex subcarrier technique. This equipment was slightly modified to accommodate the television transmitter and was used to prove the feasibility of employing existing multiplex equipment to

remotely control VHF television transmitters.

Station WGEM-TV utilized a DC wireline remote control system which was basically designed to control AM and/or FM transmitters. This unit was slightly modified to accommodate the VHF television transmitter and was used to prove the feasibility of employing commercially available DC wireline systems to remotely control television transmitters. WABI-TV followed the same course using a different manufacturer.

Reliability of Transmitters

In any broadcasting service the aspect of equipment reliability is of major importance. In order to determine the reliability of television transmitters and their associated circuitry a survey was conducted among such stations. A summary of that survey is contained in Exhibit 2. One-hundred and ninety-four TV stations reported representing a total operating time of 1,131,990 hours for 1957; 1,162,448 hours for 1958; 1,193,100 hours for 1959; 1,215,022 hours for 1960; 1,237,914 hours for 1961; and 1,257,120 hours for 1962.

The survey shows that the average television station operated approximately 6183 hours per year with an average of 4 hours 51 minutes lost air time (visual) and an average aural outage time of 4 hours 43 minutes. This represents a reliability figure in excess of 99%. It

should be further noted that of the stations reporting, approximately 50% of the outage time was the result of power failures, a situation which is, of course, beyond the control of the licensee.

Concerning the reliability aspect of the television broadcast service, it would seem from the information contained in Exhibit 2 that television transmitting equipment has reached a high state of development. It is considered that this information is representative of all types of television stations and attests to the reliability of modern day television transmitters.

Remote Control Progress in Europe

Reference is now made to Exhibit 3 which is a report of the unattended operation of television broadcast stations operated by the Cyprus Broadcasting Corporation. This exhibit describes in detail the unattended operation of two separate 40 KW Channel 8 television broadcast stations located atop Mount Olympus and Sina Oros, Cyprus. The remote control system operates entirely "off air". Information concerning 23 parameters from each transmitter are continuously displayed at the control location and 20 control functions concerning the operation of each transmitter and its associated equipment are also carried out from the remote control point. This information is included in order to acquaint interested parties with

the state-of-the-art of VHF-TV remote control in countries other than the United States.

Experimental Operation of VHF-TV Stations in the United States

In September 1962, a series of experimental field tests were undertaken at four VHF-TV stations to determine the feasibility of remotely controlling television stations operating on Channels 2-13. The following stations cooperated in this project:

KKTV, Colorado Springs, Colorado	Channel 11
KFMB-TV, San Diego, California	Channel 8
WGEM-TV, Quincy, Illinois	Channel 10
WABI-TV, Bangor, Maine	Channel 5

In the KKTV and KFMB-TV experiment, remote control functions and metering information were performed by multiplexing commands on the studio-to-transmitter line (STL) and multiplexing the metering information on the main aural carrier. This portion of the test required special authority from the Federal Communications Commission and was conducted under Special Temporary Authorization (STA). In the matter of WGEM-TV and WABI-TV, remote control functions and metering information were performed over metallic telephone circuitry between the studio and transmitter and, therefore, no special authorization from the Federal Communications Commission was required. In both these cases the Commission was informally notified of the tests. Each station maintained a First-Class

Radiotelephone license holder at the transmitter during all periods of operation covered by the experimental data included in Exhibit 4.

As noted from the engineering description of these exhibits, remotely read meter values were plotted against those read at the transmitter. It will be noted from the graphs that, except for a few periods of operation at some stations, the parameters of the remotely read values track substantially with the values read at the transmitter. In the majority of these cases, the deviations in the tracking occurred during the initial shakedown period of operation or occurred by reason of some fault which was subsequently corrected or identified.

As a specific example, station KKTV, Colorado Springs, Colorado, operated throughout the experimental period without a single malfunction of its control or telemetery system. However, the test was plagued with periodic automatic logger malfunctions which resulted at times in erratic readings. Although several loggers were installed in an effort to correct this particular problem, the complete solution could not be effected without a complete mechanical redesign of the logger mechanism. All malfunctions and discrepancies associated with this portion of the test were mechanical and were in no way connected with the electrical portion of the remote metering system. The redesign of the logger, along with

adequate calibration, would have undoubtedly resulted in perfect logger performance.

A letter written by Mr. James D. Russell, President and General Manager of Station KKTV (July 3, 1962), to the Federal Communications Commission requesting an extension of the station's STA to continue remote control tests states as follows:

> ". . . The equipment was installed and experimental operation was begun on 8 February 1962. . . The transmitter has been remotely started and stopped every day and any required adjustments to any of its operating parameters have been made remotely from the studio. <u>The remote control equipment continues to operate without a flaw</u>." (underscoring added)

In the matter of KFMB-TV it will be noted that tracking between the remote and transmitter meters is in substantial agreement and that not a single metering malfunction occurred. It can safely be stated that with adequate calibration, tracking between the two meters would result in virtually complete agreement. It will be further noted from the WGEM-TV graphs that tracking between the main and remote meter is virtually completely in agreement.

Section 73.671 of the Commission's Rules pertain to technical information which must be recorded in the operating log. This section

requires that entries be made at least once every thirty minutes of the following transmitter characteristics:

1) Operating constants of the last radio stage of the aural transmitter (total plate voltage and plate current), and

2) Transmission line meter reading of both transmitters.

In addition to this, Section 73.676 of the Commission's Rules pertaining to remote control operation of television stations operating on Channels 14-83 state that the licensee must have the capability of determining the following:

1) The power output of the visual and aural final radio frequency amplifiers or the power delivered to the antenna.

It should be noted that stations KKTV, WGEM-TV, WABI-TV and KFMB-TV fully complied with all the Commission's logging requirements as set forth in the above referenced sections of the Rules. These four stations remotely metered at the control point a minimum of aural plate current, aural plate voltage, and power output of both the aural and visual transmitters as now required by the Rules. Results of this portion of the field test prove conclusively that VHF-TV stations have the capability of accurately telemetering such information back to the remote control point.

Although this was the minimum information logged at these four test stations, KKTV telemetered a total of 14 circuits back to the remote control point, KFMB-TV relayed 9 circuit readings back, WGEM-TV remoted 23 circuit readings and station WABI-TV telemetered 8 circuits.

The experimental tests reported in Exhibit 4 represent approximately 12,100 hours of operation which were considered sufficient to prove conclusively the feasibility of remotely controlling VHF television transmitters. Other than the few extremely minor discrepancies noted, not a single major malfunction occurred with either the control functions or telemetering systems throughout the entire period of the test.

Regarding transmitter control functions, both stations KKTV and WGEM-TV performed all the control functions now required by Section 73.676 of the Commission's Rules concerning the remote control of television broadcast stations operating on Channels 14-83. Suitable controls were installed to:

(i) Turn the transmitter on and off at will.

(ii) Adjust the power output of the final radio frequency amplifier to compensate for variations in line voltage.

(iii) Determine the power output of the visual and aural final radio frequency amplifiers or the power delivered to the antenna.

(iv) Make such adjustments as may be necessary to insure that the characteristics of the transmitted signal comply in all respects with the technical requirements of the Rules.

The circuits from the control point to the transmitter were so designed and installed that open circuits, short circuits, accidental grounds, or other line faults would not activate the transmitting apparatus; and, any fault which resulted in the loss of control of the transmitting apparatus would automatically remove power from the transmitter.

In the matter of transmitted signal adjustments, KKTV controlled Pedestal and Video Gain and station WGEM-TV controlled Sync Level and Video Gain. Power output control of both the visual and aural final amplifiers was achieved by adjusting excitation and both stations had the capability of determining power output of the visual and aural transmitters. Additionally, at KKTV alarms were also activated when the aural and visual power output or aural modulation limits were exceeded.

Station KFMB-TV had the capacity of determining both visual and aural power output with appropriate control exercised over each. However, due to the design and complexity of the input equipment, it was impractical to exercise remote control over the characteristics of the transmitted signal. Such control would have required extensive modifications to the existing installation and were indeed not justifiable during the course of

this experiment.

Section 73.676 of the Commission's remote control rules for television stations operating on Channels 14-83 also state that:

> "The control point shall be equipped with apparatus suitable for observing the waveform and other pertinent characteristics of the transmitted visual signal and the percent of modulation of the transmitted aural signal."

It is interesting to note that the "off air" monitoring system installed at the WGEM-TV remote control point fulfilled all the requirements of Section 73.676(a)(2) of the Rules in regard to monitoring. This station was equipped to accurately monitor 100% sync level, 75% black level, 12-1/2% peak white level, and 0% reference white level. The Petitioner contends that this portion of the field experiment proves conclusively the feasibility of "off air" monitoring a complex video signal with accurate and consistent results. In addition to adequately monitoring the video portion of the transmitted signal, means were also incorporated into the monitor to accurately determine the percentage of modulation associated with the aural transmitter. As an added feature, an "off air" alarm was also included in the monitor unit to alert the control center in the event either the visual or aural transmitters failed.

In the case of KKTV, "off air" monitoring was accomplished through

the use of a Conrac receiver whose output was fed to a picture monitor and scope. By feeding the output of a "chopper" into the receiver, reference white level was obtainable.

It is fully acknowledged that, in some cases, there will be transmitters which are not compatible with remote control operation. Certain transmitters designed and manufactured in past years may not readily adapt themselves to remote control without extensive mechanical or electrical modifications. In many instances, such modifications could be successfully completed by the licensee, and in other cases new equipment will most likely be required. As an example of this, the KKTV transmitter was of recent design and contained all the necessary control and remote metering circuits including mechanical modifications. The other three experimental stations did not enjoy this situation and electrical and mechanical modifications were required in varying degrees. This does not, however, in any way suggest that existing transmitters cannot be successfully modified for remote control operation, but merely points out this particular aspect of the problem. It should be noted that although not specifically designed for remote operation, the transmitters at stations WGEM-TV and KFMB-TV were modified without insurmountable problems. It is the Association's position that the determination of whether or not a particular transmitter can be remotely controlled should be left to the

discretion of the licensee and handled on a case-by-case basis. The rules which we have suggested will, we believe, adequately cover each and every situation.

Recommendations for Future Authorization of Remote Controlled VHF-TV

Based upon the technical evidence contained herein the following recommendations are made:

1) That Section 73.676 of the Commission's Rules be amended to include all television stations authorized by the Federal Communications Commission.
2) That all television stations authorized for remote readings of the transmitter so as to allow the licensed operator at the remote point or the transmitter, to perform all of the functions in a manner required by the Commission's Rules.
3) That a calibration of the remote metering system with the direct reading instruments, be made at least once a week and such information be entered in the maintenance log.
4) That the installation of remote control equipment be made in accordance with good engineering practices.

5) That the functions at the remote control point be performed by a person holding a valid First-Class Radiotelephone license.

6) That remote indications of tower lighting be of sufficient accuracy to positively indicate the failure of any one light on the structure.

7) That either remote control systems utilizing metallic interconnecting telephone lines between the studio and transmitter or complete RF systems using radio circuitry between the transmitter and studio be authorized with the choice of systems resting upon the licensee.

8) That a showing be made that the transmitter is capable of being operated by remote control.

EXHIBIT 2

SUMMARY OF SURVEY CONDUCTED TO DETERMINE

RELIABILITY AND RELATED ASPECTS OF VHF

TELEVISION BROADCAST STATIONS

RESULTS OF THE NAB TELEVISION SYSTEM OUTAGE SURVEY

I. Transmitter: Please indicate total outage time in hours and minutes.

VISUAL			AURAL		
Year	Hours	Minutes	Year	Hours	Minutes
1957	4	52	1957	4	50
1958	5	12	1958	5	0
1959	4	54	1959	4	50
1960	5	33	1960	5	29
1961	4	20	1961	4	7
1962	4	19	1962	4	4

II. What are the principal causes of outages? (Check one or more)

Power failures	55.2%	Component failures	57.7%
Tube failures	51.0%	Others	19.6%

Power failures:
107 stations ranked this as 1st or 2nd priority
7 stations ranked this as 3rd or 4th priority
80 stations left blank

Tube failures:
99 stations ranked this as 1st or 2nd priority
19 stations ranked this as 3rd or 4th priority
76 stations left blank

Component failures:
112 stations ranked this as 1st or 2nd priority
17 stations ranked this as 3rd or 4th priority
65 stations left blank

Other:
38 stations ranked this as 1st or 2nd priority
20 stations ranked this as 3rd or 4th priority
136 stations left blank

III. Total number of broadcast hours for years:

1957 - 5835 hours	1960 - 6263 hours
1958 - 5992 hours	1961 - 6381 hours
1959 - 6150 hours	1962 - 6480 hours

IV. Do you have a standby transmitter?

33.5% answered yes to this question
66.5% answered no to this question

V. If so, what power?

52.3% had a 5 kw standby transmitter
16.9% had a 2 kw standby transmitter
30.8% had standby transmitters of miscellaneous powers ranging from 1 kw to 50 kw exclusive of the 5 and 2 kw category

VI. Total number of hours standby transmitter operated during the years:

1957 - 14 hours	1960 - 16.4 hours
1958 - 10 hours	1961 - 11.0 hours
1959 - 11.3 hours	1962 - 16.0 hours

(Note: The above hours include operation during the failure of the main transmitter and auxiliary transmitter testing as required by Section 3.638 of the Commission's Rules.)

VII. If you operate with separate studio/transmitter facilities, do you use an STL?

66.0% answered yes to this question
19.6% answered no to this question
14.4% indicated that this question was not applicable

VIII. Do you have an auxiliary antenna?

34.0% answered yes to this question
66.0% answered no to this question

EXHIBIT 3

REPORT OF UNATTENDED VHF TELEVISION TRANSMITTER OPERATION ON THE ISLAND OF CYPRUS BY THE CYPRUS BROADCASTING COMPANY

DESCRIPTION OF THE REMOTE CONTROL AND SUPERVISION OF TELEVISION TRANSMITTERS IN THE CYPRUS EXPERIMENT CONDUCTED IN CONJUNCTION WITH PYE TELECOMMUNICATIONS, INC.

In Cyprus two broadcast transmitting stations, each having dual video and audio transmitters with a common program input, are controlled from a single studio center. These TV transmitters are on mountain tops, on Mount Olympus and Sina Oros, and because of difficult access and prevailing poor weather conditions, there has, for some time, been a real need for remote control and supervision.

VHF radio and microwave link has, therefore, been arranged on Cyprus between a studio center in Nicosia, and the two entirely separate (but paralleled) transmitters on Mount Olympus, and at Sina Oros. Both these transmitters are 40 kw ERP Channel 8 units, each with two video and two audio transmitters in parallel. As landlines are difficult in this terrain, program information is normally carried to the transmitters by microwave link, and duplex VHF radio links are used for the supervisory and control data.

Information regarding the condition of 23 points at each transmitter is continuously displayed at the central Nicosia station and, by selection, twenty control functions concerned with the running-up, shut-down

and changeover of the transmitters and associated equipment can be carried out for each station from this point.

Most telemetry systems fall into two broad categories, analogue or digital. It is in the latter field where the most significant advance has been made for TV-transmitter remote control, as well as in the worlds of missile and outer-space research programs. In the Pye Telecommunications system used in the Cyprus experiment, and now being installed at other television transmitters throughout the world, digital techniques are used.

For television supervision and remote control, a digital system provides great flexibility, is fast, easily extended, can provide direct digital readout and printout, is economic in channel bandwidth requirements, can use self-checking or error-correcting codes, and also has other advantages.

The system operates when instructions and information are given in the form of stereotyped commands. In this system, codes are transmitted from the master station to interrogate out-station meters and alarm points sequentially. This is carried out automatically by a programmer designed to operate a display of the various readings at pre-determined intervals, or on demand.

The programmer is also capable of repeating certain parts of the sequence in the event of any error in the codes. In addition, provision is made for the insertion of command codes to control functions at the out-station as required by the operator. The use of a central control or programming system offers many advantages over independent systems, and if the bearer circuit is shared by a number of out-stations, then in TV practice this central control becomes a necessity.

Whether the bearer circuit adopted be line or radio, the economics will determine that a single central programmer will be required in most cases. The programmer arranges for the point selections and command codes to be transmitted, and executes one of these functions at a time in a TDM system. Thus, if a control is being undertaken at a particular station, information from other stations is held up in a continuously scanning system. This disadvantage is overcome in an integral scanning system, since controls can be undertaken in the quiescent periods.

These telemetry systems also incorporate self-reporting alarm facilities, which again obviate the need for continuous scanning. Furthermore, the relatively slow rate of change of most of the measured variables (even on a TV transmitter network) is significant; clearly, continuous scanning in such circumstances is unnecessary.

Bearer Circuits

The features of integral scanning coupled with self-reporting alarms are very advantageous, when radial radio-links are used, as can often be the case with TV transmitter networks. Out-stations are allocated the same radio frequencies, and inter-scheme interference is minimized by the various links only being energized for a minimal period each hour. In this type of layout, all points within a TV or other transmitter are scanned sequentially, and thus by employing the full bandwidth of UHF links (6 Kc/s), speech and telemetry may take place simultaneously at one selected out-station. This is a great advantage in the routine breakdown maintenance of the complete network.

In some instances, natural barriers preclude the use of land-lines or radio, and often radio and line connections are used in the same system. So far as costs are concerned, a typical single UHF radio link breaks even with a rented line, at approximately 15 miles.

At greater distances than this, some cost advantages will occur. If a common repeater station is already in use, an additional radio link compares cost-wise with a rented line at a distance of about six miles. From the reliability point of view, the outage time of an average land-line could work out at 25 hours per annum, whereas outage time for a

good radio link would probably be not greater than one hour. If even greater reliability is required, duplicate radio links with automatic change-over equipment can be used.

Cold Cathode Tubes

In designing telemetry systems, the cold cathode trigger tube (which can be described as a medium-speed device) is considered as a relatively inexpensive, robust and versatile component, which, in many cases, can simplify the design of complex switching systems. The fact that the cold cathode tube is a two-state device, which possesses memory and is also self-indicating, is very important in this respect.

Considerable work has been done to determine the life-expectancy in cold cathode tubes in various telemetry applications. In many cases the duty cycle of the type in digital equipment is quite low, and a tube might well conduct only 50% of the operating life of the whole equipment.

The actual percentage depends on the particular application. For the remaining time, the tube is in the standby condition and, therefore, its useful life is the sum of the conduction and standby times.

It would appear that standby or "shelf-life" is very satisfactory,

and tests lasting 40,000 hours have shown only small and random variations. At a certain current[1/] a tube may have an operating life of 3,000 hours, and only be conducting for 20 minutes a day. This gives an operating time of 120 hours per year, and therefore a life equivalent to 25 years can be expected.

Another tube operating under different conditions for five minutes each day might well last 100 years. Under certain self-extinguishing conditions, where peak current is higher but mean current is lower, a tube might well function for over 500,000 years, or nearly fifty years. Up to the present, failure-rate figures of the order of 0.01% per 1,000 hours are being obtained.

Because of the simplification of some telemetry design, the self-indicating properties and the fact that the cold cathode tube is unaffected by high temperatures and voltage and current overloads, the use of these tubes instead of transistors might well solve the costly maintenance problems usually associated with complex electronic equipment.

For instance, it is quite possible to operate telemetry equipment

1/ It has been confirmed that the operating life is inversely proportional to some power of the current drawn.

at a very low speed, and to observe visually the operation of the cold cathode tube logics circuit; or a set routine program can be sent out and the correct operation checked stage-by-stage without the use of any test equipment whatever.

Analogue to Digital

At each out-station point, selection equipment energizes a dry reed relay which connects the selected transducer to the comparator of the analogue-to-digital converters.

A reference signal (which can be varied in fixed steps) is also fed to the comparator, which provides an output pulse whenever the reference signal is greater than the transducer signal. This reference signal is equated to the transducer signal in a 12-step balancing sequence, which allows the transmission of a three-digit number in binary-decimal code.

The balancing sequence is divided into three groups of four steps each. In the first group, the reference signal is adjusted in consecutive steps of 80, 40, 20 and 10 percent of its maximum value. In the second group, the steps are reduced to 8, 4, 2 and 1 percent, and in the third group to 0.8, 0.4, 0.2 and 0.1 percent.

For each decade, dry reed relays (controlled by the analogue-to-digital converters logic circuits and the comparator) are operated in a fixed sequence to adjust the reference voltage until balance is obtained. During this process, the logic tubes associated with the reference signal are scanned by the programmer at control-point, to give information in binary-decimal form with a digitized accuracy at 0.1%. This complete operation takes up a period of some 250 milliseconds. The coding arrangements of the analogue-to-digital convertors are illustrated by the accompanying diagrams.

The reference signal is derived from the resistance chain built up of high, long-term stability, zero temperature coefficient resistors, the accuracy being 0.01% in the severest case. Sealed dry reed relays in addition to a solid-state constant-current device ensures that the signal supplied to the reference chain is maintained at constant level.

Analogue-to-digital converters comprise eight plug-in modules, and the system has been designed so that all modules of a given type are interchangeable without the need for separate adjustment. Since cold cathode tubes are used in the logic circuit, visual detection of any malfunctioning can be seen immediately. The faulty unit can be withdrawn and replaced with a serviceable unit, in a matter of seconds.

The accuracy of the analogue-to-digital converter may be checked by a test unit which provides an accurate number of precisely-controlled signal currents covering the range 0-10 ma. This unit is connected to the input of the analogue-to-digital converters, and the signal is digitized.

State of the analogue-to-digital converters can be ascertained visually to check that the digitized reading in binary-decimal form, corresponds to the current applied from the test unit. This operation can be repeated over the 0-10 ma range and the transmission accuracy can also be checked at the control station at the binary-decimal, decimal print-out and analogue (meter reading) stage.

Operating the System

This system makes use of voice frequency signalling employing two tones. One tone, the pilot, always recurs at a fixed time interval, and interlaced with this tone is either a fixed period of silence (space) or the second tone (mark). In the basic Pye system, a 12-unit mark/space code is employed. The first four units give the station identity, and the remaining eight units indicate the state of the alarm contacts. When the system is extended to full capacity, the code length is 72 units.

Sub-station equipment is normally quiescent, but in the event

of an alarm occurring the equipment is automatically energized, and after a short delay the station identity and alarm information is transmitted.

This delay period (which is different for each sub-station) serves to prevent two or more sub-stations reporting simultaneously on a fault common to these stations.

At the control station, the code information is translated and displayed in a common diagram form on the annunciator and, at the same time, an audible alarm is given.

Until this display is accepted, a hold-off signal on pilot tone frequency is transmitted by the control station equipment. This tone prevents any further alarm information from the sub-stations being transmitted. When the display is accepted, the hold-off tone is silenced, so permitting any further alarms to report.

To check the alarm state of all sub-stations, a test facility is provided. When the test key is pressed, a continuous signal on pilot tone frequency is transmitted to all sub-stations for a pre-determined period of time, and on receipt of this tone all sub-stations are energized and will report in sequence, according to the pre-arranged delay.

The voice-frequency multiplex supervisory equipment gives a

tone-operated switching link between monitoring and indicating devices remotely situated apart; in fact this system allows the transmission of up to six independent on/off indications simultaneously, and is suitable for use with any single bearer circuit which can accept the range of audio-frequency tones employed. This gives a very wide variety of possible applications.

Six tone generators situated at the monitoring position, provide outputs in the range 400 c/s to 3.1 Kc/s, and are keyed as required by the local transmitter and station needs.

Mixed outputs are fed to the bearer circuit and separated at the receiving position where the tones are applied to actuate suitable switching circuits for the indicating equipment.

Components are mounted on grid-referenced printed circuit boards, each board being housed in a rigid frame to form a series of plug-in units. These are mounted in a front-flanged 19-inch rack-mounting case. Semi-conductors are used throughout, and test points are provided on each unit to allow rapid location of a faulty unit in the event of a breakdown. The removal of a channel unit for maintenance does not, incidentally, affect the working of the remaining channels.

A 12-volt DC supply is required for sending and receiving equipment, and an AC main-driven power supply is available to provide the required voltage. This unit is mounted on a separate 19-inch rack. All circuits are isolated from the chassis, which thus permits connection to external circuits that may be operating at higher potential.

Telescan Technique

As a continuously-scanning contact monitoring system (using VHF multiplexing equipment), the basic equipment will monitor twelve contacts at one out-station, and the capacity can be increased in steps of twelve contacts to a number which is determined by the length of time which can be allowed before any given contact is re-scanned. The fundamental scanning rate is 20 contacts per second, and this can be increased to 100 per second.

One of the Teleplex channels is used for the sync-ing, and each of the remaining channels can carry information concerning 20 contacts every second. The use of the five information channels will, therefore, allow the state of 100 contacts to be up-dated every second. Omnibus or radial bearer circuit arrangements can be used. When omnibus working is employed, the most distant out-station will generate the sync pulses which are transmitted to the next station. This slave station will be

driven by the sync pulses and will transmit its information together with the amplified signals from the first station.

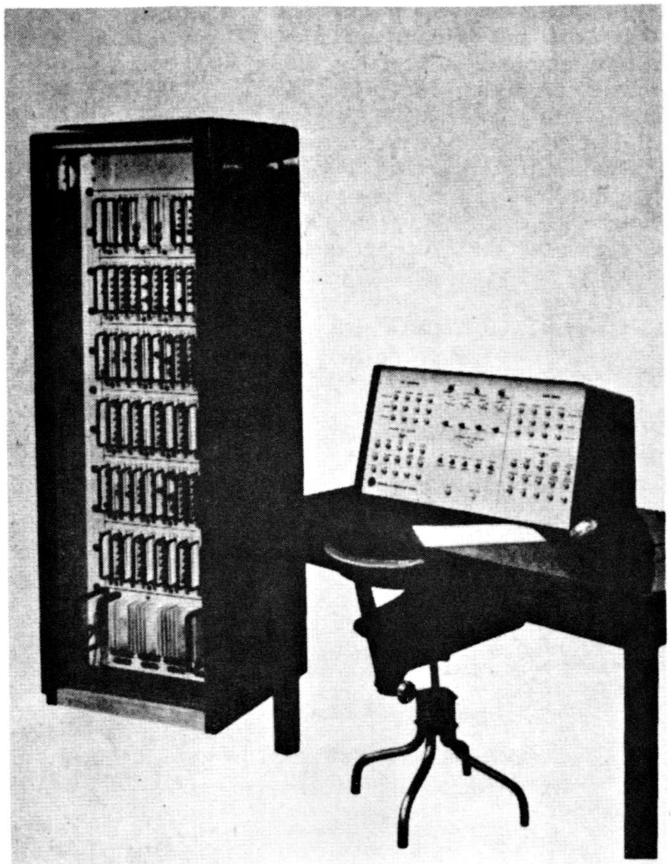
Slave information may use another channel, or it may be added to the information from the first channel. The display station is driven by the sync pulses, and decodes the full set of information which is displayed in an illuminated diagram form. When radial bearer circuits are used, duplex operation is necessary. The sync pulses are generated at the display station and transmitted to all stations which send their information directly back to the display point sequentially on one channel, or on separate channels.

Several telecontrol systems are available, based on the foregoing philosophy. Telecontrol equipment in fact comprises a telephone dial, a transistorized audio tone generator and a detector and some form of selector device.

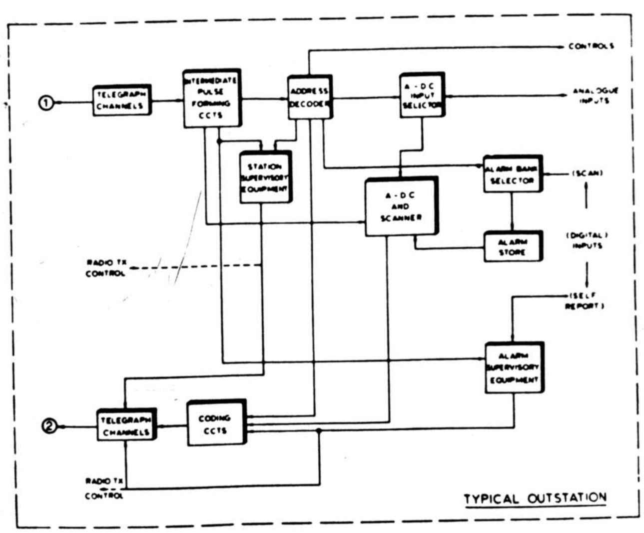
The dial pulses the tone a number of times numerically equal to the dialed digit, and at the remote station the selector is stepped in sympathy.

Any mutilation of these codes will cause the selector to drop out. Many thousands of codes are available, giving a wide choice of different

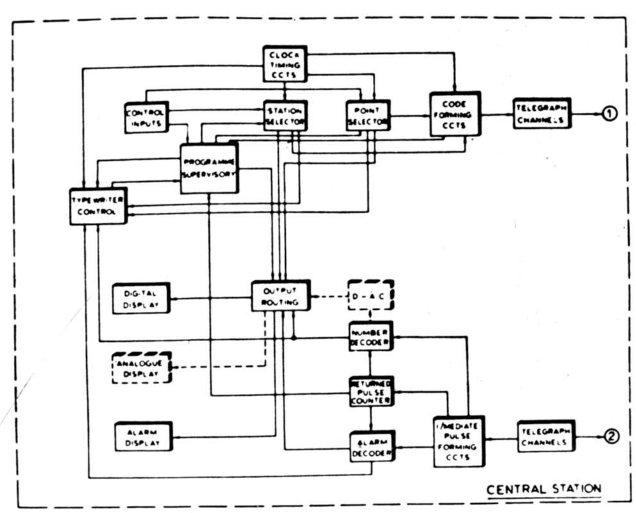
codes at any one station. This telecontrol equipment can be incorporated in any of the alarm schemes described, and thus a return indication of correct control action is available.



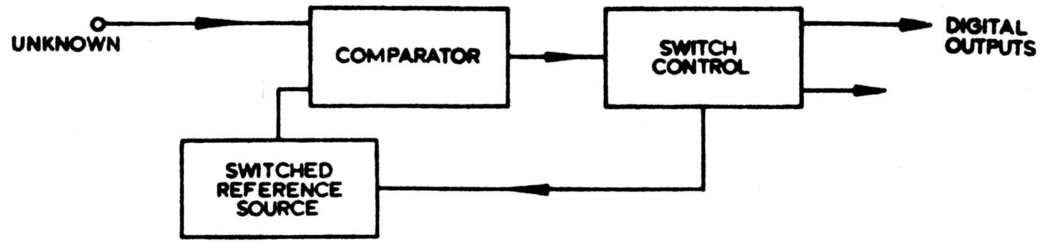
Remote control panel for two television transmitting stations at Mt. Olympus and Sina Oros in Cyprus



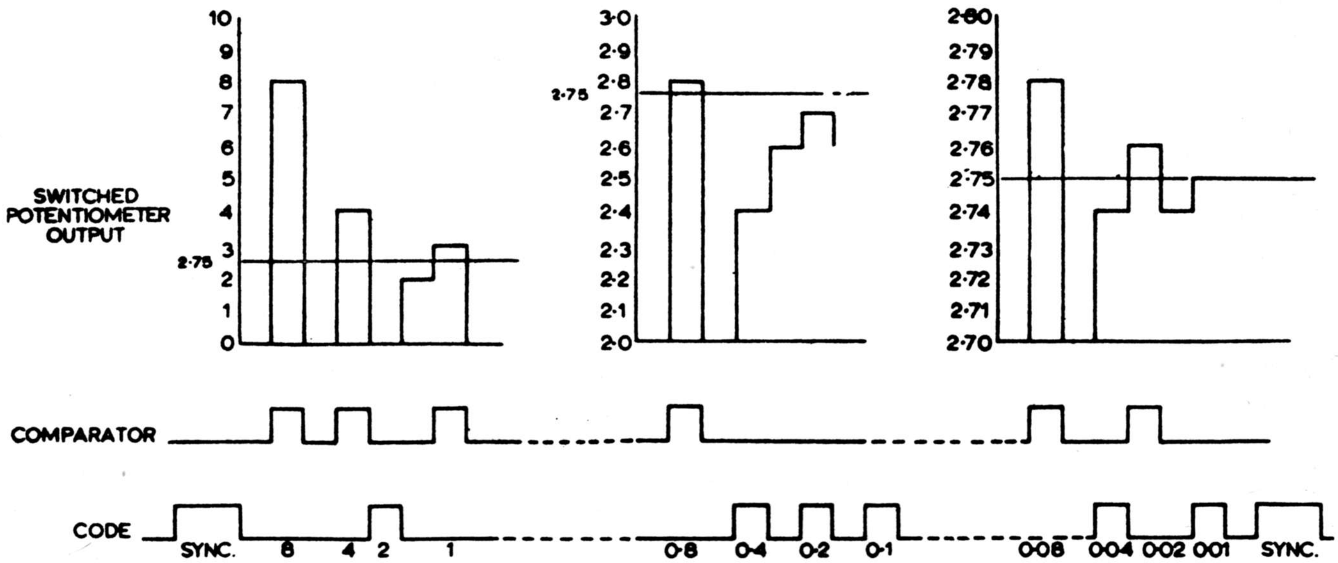
Typical out-station units, in a block schematic of a telemetry system suitable for monitoring a television transmitter network



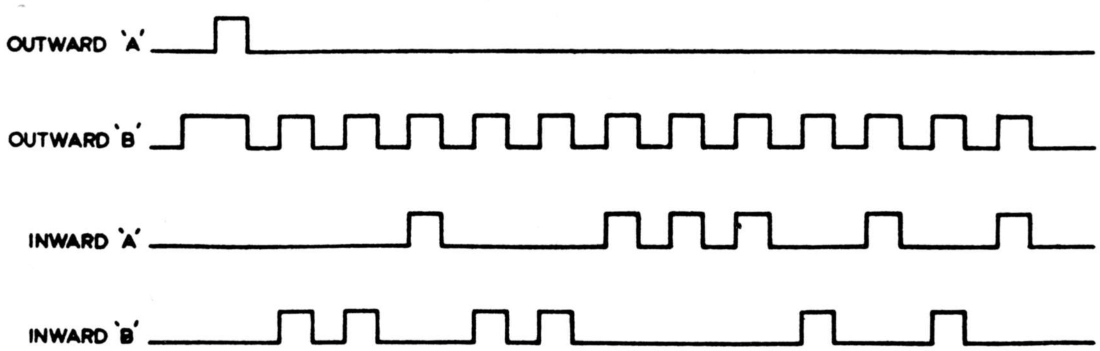
Simplified block schematic diagram of a typical telemetry system, showing the units at the central station



ANALOGUE TO DIGITAL CONVERTER

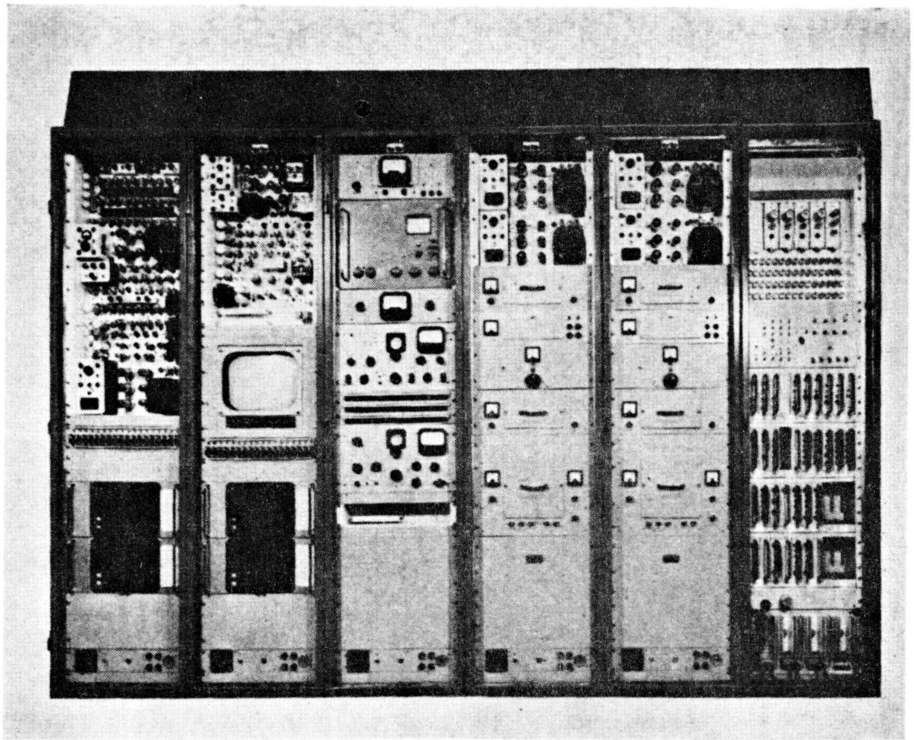


SWITCHING OF POTENTIOMETER AND RESULTANT CODE FOR READING OF 2·75

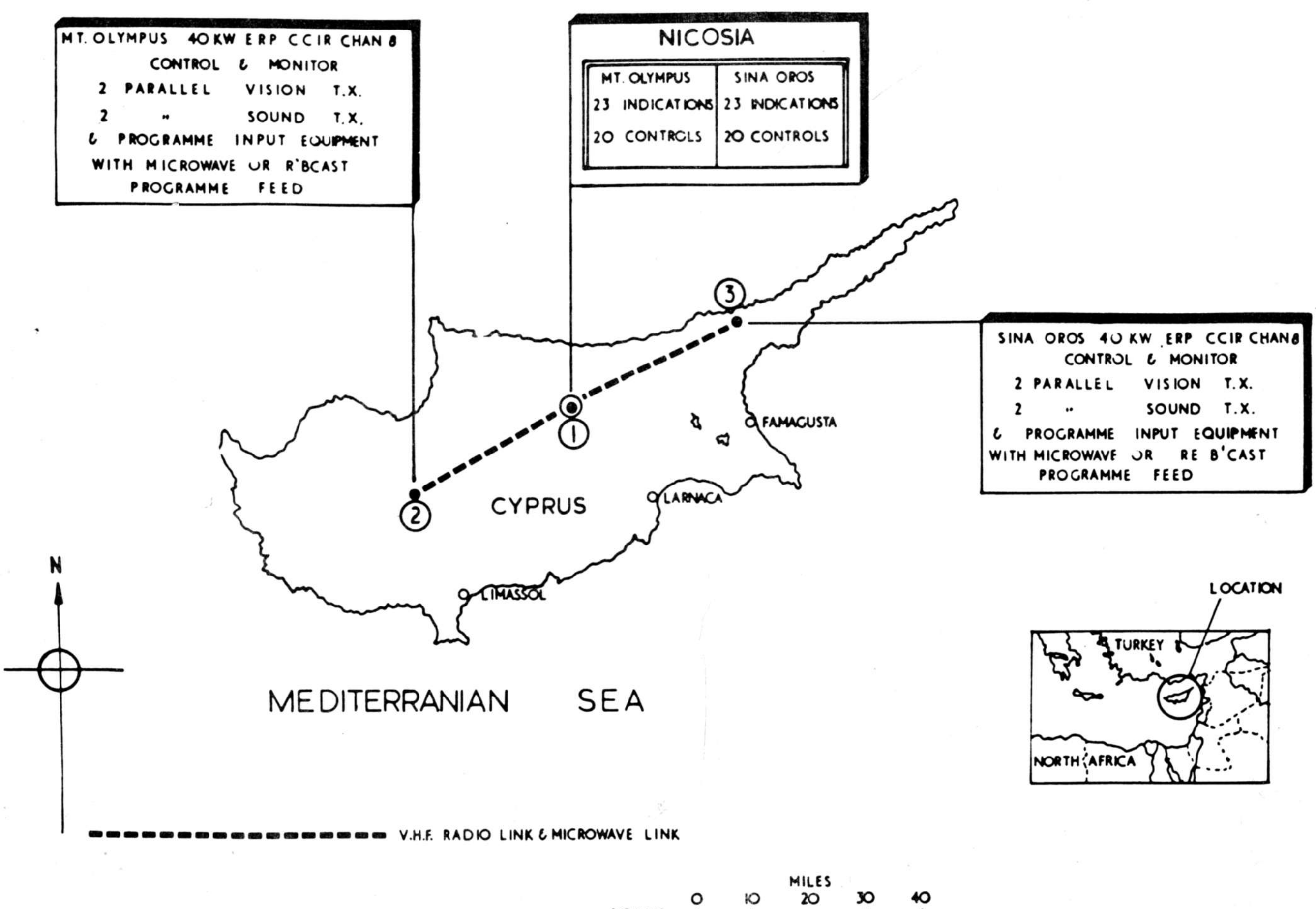


CODE FOR SCAN (READING 2·75)

Operation of analogue-to-digital converter



Transmitter programme input equipment and telemetry equipment



The Cyprus scene—television transmitters at Mt. Olympus and Sina Oros, remotely controlled and monitored at Nicosia

EXHIBIT 4

REPORTS OF EXPERIMENTAL REMOTE CONTROL

OPERATION OF VHF TELEVISION STATIONS IN

THE UNITED STATES

REMOTE CONTROL EXPERIMENT

KKTV

Colorado Springs, Colorado

INTRODUCTION

Station KKTV is licensed to the Garvey Communications System, Inc. and operates on Channel 11, assigned to Colorado Springs, Colorado. The studios are located at 512 South Tejon, Colorado Springs and the transmitter atop Cheyenne Mountain (Coordinates N 38-44-41, W 104-51-41). The station is authorized to operate with a visual power of 85.1 kilowatts Effective Radiated Power employing a tilted directional antenna, at a height of 2380 feet above average terrain.

The primary purpose of the KKTV remote control experiment was to determine the feasibility of remotely controlling a TV transmitter specifically designed for this type of operation utilizing an off-the-air control system entirely new to broadcasting. The remote control equipment was supplied by the Radio Corporation of America (RCA) through its Broadcast Communications Division.

On December 19, 1961, KKTV received the following FCC Special Temporary Authorization to conduct remote control experiments and, through extensions granted by the Commission, held such authorization until January 9, 1963:

> ". . . In order to conduct experimental automatic logging and remote control utilizing facilities of Station KKTV during regular program operation, temporary

authority granted to multiplex subcarrier on TV STL Station KAL-40 consisting of Station KKTV transmitter remote control signals. Also temporary authority granted to multiplex two subcarriers on KKTV aural transmitter consisting of automatic logging and alarm telemetering information. Above non-standard transmissions shall be in exact accordance with the engineering specifications contained in engineering report accompanying your request. Regular operators as prescribed by Section 3.661 Rules shall be in full control of KKTV transmitter and normal logs as prescribed by Section 3.663 Rules shall be maintained at all times KKTV is operated. This authority expires March 31, 1962, unless sooner terminated at discretion of the Commission. Consideration will be given to request for extension timely filed with regard to circumstances then prevailing. Any request for extension should be accompanied by a preliminary report on performance and observations of experimental operation up to that date. The Commission shall be advised when operation commences under this authority."

The equipment was installed and experimental operation commenced on February 8, 1962. The tests were conducted through December 1962, and the automatically logged data was taken from September 1, 1962, through December 26, 1962.

The holder of a First-Class Radiotelephone license was present at the transmitter during all periods of operation as required by Section 73.661 of the Commission's Rules. A regular transmitter log was maintained and the transmitter was under the immediate supervision of the First-Class

license holder at all times. A telephone talkback circuit was provided between the transmitter and studio (remote control point) and a continuous check was made on the operation of the system.

DESCRIPTION OF TRANSMITTER

General

Station KKTV utilizes an RCA Type TT-11AH VHF television transmitter which operates on Channel 11. The transmitter is designed to conform with all FCC standards and will provide a nominal power output of 11 kilowatts peak visual power measured at the output of the sideband filter and 6 kw aural power.

The transmitter was originally designed for remote control as well as local operation. It can, with the addition of suitable terminal equipment be operated from a remote location over a single telephone line. All the necessary operating functions such as starting and stopping the transmitter, resetting overloads, switching in the spare crystal or spare exciter, metering all power circuits and reflectometers, controlling power output (including black level, video gain, and excitation) can be performed at the remote location. All the basic motor control systems, wiring, rectification units, etc. are an integral part of the basic transmitter and external connections between the transmitter remote control terminal blocks and the remote control system are all that is required. No transmitter or circuit modifications were necessary to operate by remote control.

Circuit Description

The visual and aural exciter circuits of the TT-11AH are mounted on a single chassis and use two separate crystal oscillators. This allows switching from a remote point by a relay in the d-c circuit. No relays are then necessary in the r-f circuit. A special buffer amplifier allows the crystal oscillators to be operated at a low level. This reduces internal heating of the crystal and allows the oscillator frequency to stabilize very quickly after the plate power is applied. The buffer stage is followed by a tripler, two doublers, and an amplifier. The output power of the exciter is approximately 5 watts at 1/3 the carrier frequency. The aural chain starts with a master oscillator frequency modulated by two reactance tubes. The multipliers and amplifiers which follow the master oscillator are identical to those used in the visual side. A unique feature of this exciter is the frequency control circuit for the aural master oscillator. This circuit is designed to accurately maintain the difference between the aural and visual carrier frequencies. This is accomplished by feeding a small amount of the energy from the aural and visual oscillators to a mixer tube. When the aural oscillator is on frequency the output of this mixer will be 1/12 of the difference between the aural and visual carrier of 375kc. This 375kc signal combines with the output of a crystal oscillator

in a second mixer. The sum of these two frequencies is amplified and fed to a chain of three dividers with a total division of 100. This amount of division is necessary in order to reduce the swing at the frequency detector to a point where the carrier will not drop out under any conditions of modulation of the aural transmitter. A crystal control frequency is also fed to the frequency detector. By making the crystal oscillator function, both as a heterodyne oscillator and as a frequency reference source, considerable improvement in frequency control accuracy is obtained. Three dividers with a total division of 80 are also employed in the reference frequency circuit. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator. A frequency interlock circuit connected to the output of the frequency detector will prevent the application of plate power to the power amplifiers until the frequency control circuit is locked in.

R-F Circuits

The r-f circuits employ a chain of amplifiers. In the visual chain a tripler drives an amplifier which in turn drives a grid modulated stage.

This is followed by a single class "B" linear amplifier. In the aural chain the exciter output is fed to a tripler stage. This stage is followed by a class "C" amplifier which then drives a final amplifier also operating class "C".

Plate voltage is furnished from a high voltage supply employing mercury vapor rectifiers. Regulated supplies are used for screen and bias voltages.

Control Equipment

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary are provided. This includes both thermal and magnetic trips. The primaries of the high voltage rectifier and each power amplifier tube are protected by instantaneous d-c overloads which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it is intermittent. A three phase line regulator which automatically regulates the line input to the entire transmitter is utilized.

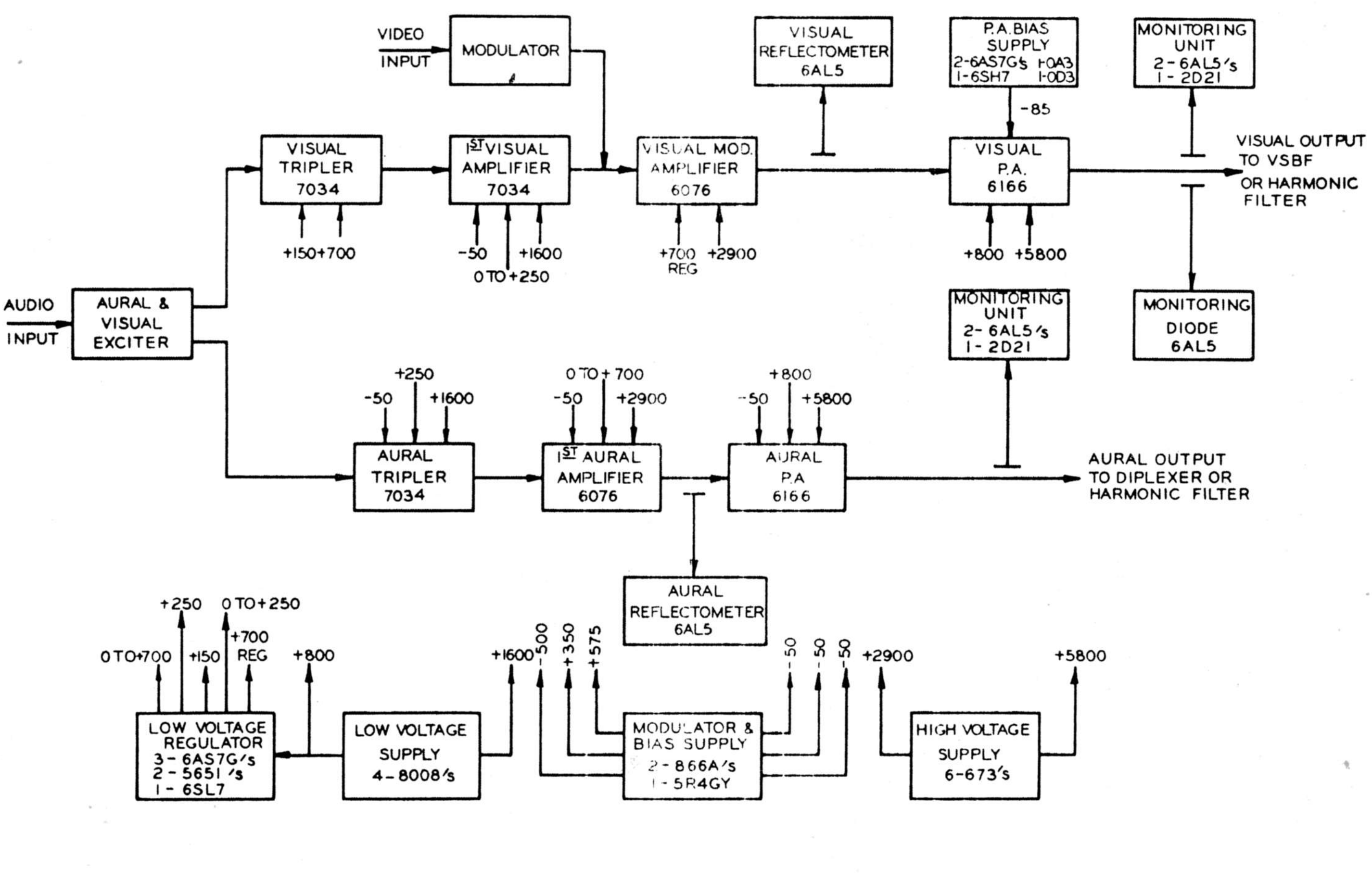
Modulator

The modulator of the transmitter is designed to take a standard 0.7 volt video signal. The first stage of the modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage each of which has a gain of approximately one. The linearity corrector is designed to pre-distort the signal to compensate for the non-linearity which always occurs in a grid modulated stage, and takes the form of four diodes connected in the cathode circuit of that stage. The bias voltage on each diode is separately adjustable and can be made to start conducting at any brightness level. The grid of this stage is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second and third video amplifier. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output stage is a shunt regulated cathode follower. The cathode resistor has been replaced by three tubes operating in parallel. The grid of these three tubes are fed with a signal of opposite polarity from the plate load by the two cathode follower tubes. This essentially makes the circuit a feed-back amplifier of high efficiency capable of delivering modulation at a high level to a large capacity load.

The output stage is followed by a bucking bias supply. This serves to transfer the signal from the positive voltage present in the output of the modulator stage to the negative voltage required to modulate without losing the d-c component. Back porch clamping is employed. A carefully designed sync separater and clipper circuit provides reliable clamping even with greatly degraded input signal.

A two-stage monitor amplifier is employed. It can be noted from the block diagram that this monitor amplifier can be switched to many parts of the circuit greatly aiding in making adjustments and in servicing. Plate power for all the stages in the modulator is obtained from two electronic regulators. One supplies approximately 250 volts and the other approximately 475 volts.



REMOTE CONTROL SYSTEM

General

The remote control equipment tested at KKTV, was designed and fabricated by the Radio Corporation of America (RCA). The philosophy upon which this design was based was predicated on many years of experience in the operation of television equipment and followed the following design concepts:

1. The large financial investment in a modern television plant would require telemetering equipment equal to at least that which is now in general use in the power transmission and pipe line fields.
2. Many of the television transmitter plants are situated in remote locations which makes it mandatory that the control and telemetering information be carried on a STL subcarrier and the metering information transmitted back to the studio on a subcarrier of the aural transmitter. The use of metallic lines would not be necessary, although they could be used if required by certain systems.

3. The design must be such as to minimize human effort and relieve manpower from routine duties; therefore, supervisory alarms and automatic logging should be featured.

Many types of telemetering control were considered, and as the subcarriers were to be multiplexed on the microwave and sound carrier, limitations were placed upon the system bandwidth. In the commercial telemetering field, the binary scan method was the most widely accepted system for control and readout functions. By the selection of this type of system, a 20-function control unit could be accommodated in a bandwidth of $\pm$ 250 cps.

Other systems were explored to handle the telemetering information of the transmitter parameters. The use of a binary system was discarded as the information to be transmitted was analog in nature and a digital-to-analog converter was found to be extremely expensive. Therefore, a system was developed which was completely analog and had an over-all accuracy greater than 1%. This type of system had been in use in the commercial telemetering field and is known as a pulse width integration system. This type of equipment has wide acceptance in the pipe line field and is extremely reliable.

To control and automatically log, the following equipment was required:

STUDIO

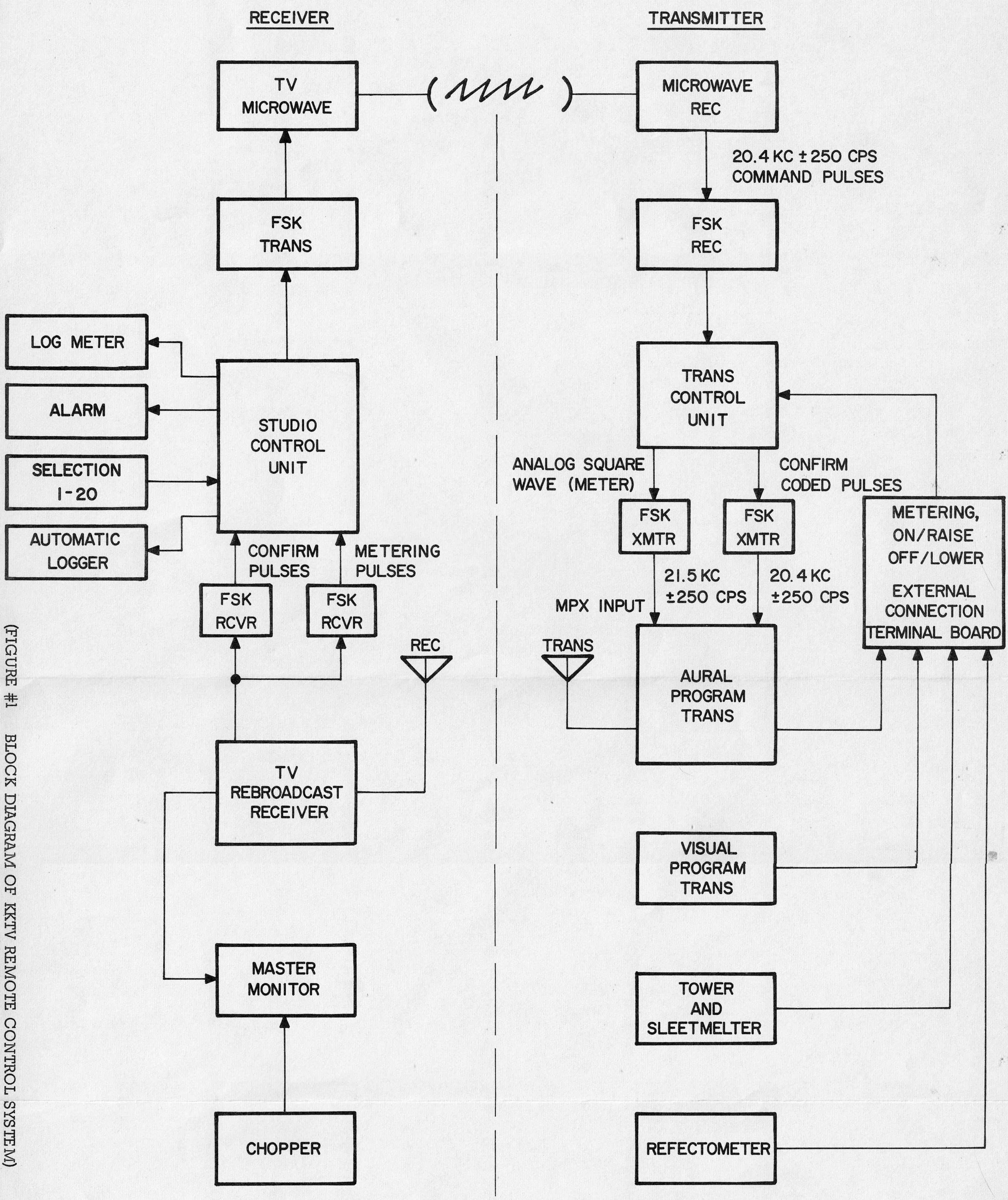
1. Studio control and alarm unit
2. Analog telemeter receiver
3. Aural and visual carrier receiver
4. Automatic logger
5. Audio and video monitoring equipment

TRANSMITTER

1. Transmitter control unit
2. Analog telemeter transmitter
3. Power limit sensing and remote frequency indicating unit
4. AC line pick-up units
5. Tower lighting and sleetmelter AC pick-up units

System description and operation

The system selected has a capacity of twenty control functions and/or meter indications (selectable in any sequence) and eight independent and simultaneous alarm circuits. The operation is accomplished by means of FSK carriers and can therefore be utilized without metallic wire lines between studio and transmitter, i.e., on microwave relay or through telephone switching controls. Figure #1 represents a block diagram of the remote control system at station KKTV. A total of three FSK channels are used. One channel transmits the function and control commands from the studio to the transmitter, a second carries the selection confirmation and alarm information from the transmitter to the studio, and the third carries the analog meter indications also from the transmitter to the studio. Function and control selection is accomplished by binary techniques, both at the studio and at the transmitter,



TV TONE REMOTE CONTROL SYSTEM

FIG. 1

(FIGURE #1 BLOCK DIAGRAM OF KKTV REMOTE CONTROL SYSTEM)

utilizing semiconductors on printed-wired, plug-in boards. The meter information is transferred from the transmitter to the studio by a voltage-to-frequency analog transmitter and receiver.

In this experiment, the studio (remote control center) and transmitter are linked together through the use of subcarriers operating in the following manner:

1. One 20.4 kc subcarrier is diplexed on the aural STL carrier. This subcarrier carries the transmitter control information and has a bandwidth of 250 cps. The deviation is less than 10% of that required by the program audio signal.
2. Two subcarriers are injected into the TV transmitter aural exciter: one at 20.4 kc (±125 cps), the other at 21.5 kc (±125 cps). Both are recovered at the studio from the audio output of the rebroadcast receiver for application to the FSK receivers. The total deviation of both these carriers is less than 10% of the 25 kc allowed for what is considered 100% modulation of the aural carrier. To prevent overmodulation the swing of the program sound is reduced by 10%. This amount of reduction does not

degrade the quality of reception under normal conditions.[1/] The bandwidth of both subcarriers is 1.6 kc (250 cps for each, with a 600 cps guard band between). These subcarriers carry the alarm circuit and transmitter telemetering information respectively.

The system has an accuracy of 1% or better. The binary and analog units are slight modifications of equipment that has established itself as being extremely reliable in other remote control fields, such as transcontinental gas and oil line remote control and monitoring applications.

Fail-safe is provided by means of constant scanning of the transmitter "ON-OFF" control function. Should this function fail, the transmitter will instantly shut down.

1/ It should be noted that under conditions of 100% modulation (90% program plus 10% subcarrier) the amount of energy represented by the subcarrier is at least 20 db below that of program material. The standard de-emphasis curve employed in conventional television receivers between the output of the sound discriminator and the input to the first audio amplifier provides an additional attenuation of 20 db at subcarrier frequencies. Therefore, without considering the natural roll-off of the human ear and the added roll-off of such frequencies in the audio system of the average receiver, the subcarrier information is at least 40 db below program information. As could be expected, the operation was not found to impare reception.

Control

In the KKTV installation, the following functions were remotely controlled: 2/

Selection	On/Raise	Off/Lower
1	Start	Stop
2	Plate On	Plate Off
3	Pedestal Raise	Pedestal Lower
4	Visual Exciter Raise	Visual Exciter Lower
5	Video Gain Raise	Video Gain Lower
6	Aural Exciter Raise	Aural Exciter Lower
7	Crystal No. 1	Crystal No. 2
8	Overload Reset	----------
17	Tower Lights On	Tower Lights Off
18	Sleetmelter On	Sleetmelter Off

Alarm

In addition the following alarm circuits were employed:

1. Transmitter Building Overheat
2. Visual Air Overtemp
3. Aural Air Overtemp
4. Overload
5. Aural Modulation Flasher
6. -----
7. Aural Power Limit
8. Visual Power Limit

Relays actuate the alarm circuit if the readings exceed pre-set limits. In the case of aural or visual power output, the reflectometer relays actuate

2/ Although these were the only control functions incorporated, the system is capable of handling an additional twelve functions.

the alarm circuit if the power output of either the visual or aural transmitter exceeds pre-set limits of plus ten percent and minus twenty percent as specified in Sections 73.689(b)(1)(2) of the Commission's Rules. Limits for alarm circuit actuation can, of course, be set to any desired value.

Metering and Logging

Automatic logging is accomplished by scanning with a sequential switch all transmitter parameters which are of interest. The scanner is located at the transmitter and is timed by a synchronous motor. The output of the scanner is fed to one of the control function positions so that when the remote control unit is not in use, the scanning function is activated and the system operates in that position. This position provides the automatic logger with metering information that is selected by the sequential scanning system. Each parameter is scanned and read sequentially once every 30 minutes. For instance, visual power output is recorded in position 5; therefore, position 5 would repeat on the recorded chart at 30 minute intervals. Each of the 24 positions remains on for approximately 1 minute and 15 seconds, thus requiring 30 minutes for the complete set of 24 readings to be taken.

A reading of any of the 20 parameters may be taken manually by activating the desired button on the control console and reading the meter.

These readings are shown on an arbitrary scale of 0 to 150 and a correction factor must be applied. Normal readings for any function may be preset to produce a conveniently correctable reading.

Station KKTV automatically logged all functions as set forth in Section 73.671 of the Commission's Rules.

After considerable experimentation it was found that the aural and visual frequency deviation monitors currently employed at station KKTV were not ideally suited to remote operation without extensive modifications. This would necessitate the installation of meter-potentiometers to translate the aural and visual frequency meter indications to voltage for application to the remote metering circuit. This would require the placement in series with each monitor meter an additional meter whose pointer moves over a resistance card. To read frequency remotely, a solenoid would be actuated to clamp the pointer on the resistance card, and the voltage between the pointer and ground would then bear a fixed relationship to the frequency. This would then be read on the remote meter at the studio. Although it would have been desirable to read aural and visual frequency deviation remotely, it was felt that such extensive modifications to the existing monitors were not justifiable at this time.

The following remote readings were available in the sequence tabulated below:

Automatic Log Position	Function Being Read	Auto Log Calibrated To Read	Normal Transmitter Readings
1	Phase #1 AC	100	200-210 Volts
2	Plate Voltage (Aur and Vis)	118	6700 Volts
3	Visual Bias Voltage	75*	
4	Visual Excitation	86*	
5	Visual Power Output	100	100
6	Aural Power Output	100	100
7	Aural Plate Current	50*	1.42 Amperes
8	Aural Screen Voltage	34*	
9	Visual VSWR	3	
10	Aural VSWR	16	
11	Calibrate	0	
12	Calibrate	0	
13	Calibrate	150	
14	Calibrate	150	
15	Phase #2 AC	100	
16	Visual Plate Current	75**	1.4 - 2.2 Amperes
17	Visual Frequency	72*$\emptyset$	0
18	Aural Frequency	75*$\emptyset$	0
19	Mod. Amp. Plate Current	17**	
20	Regulated Filament Bus	100	
21	Unused		
22	Unused		
23	Unused		
24	Unused		

Note: * These readings will vary ± 10%.
** These readings will vary ± 50% depending on picture content.
$\emptyset$ Frequency deviation not read during experiment.

The reported tests cover a period from September 1, 1962, to December 26, 1962. On October 19 the order of logging was revised to become 13-18, 7-12, 1-6, 19-24. In all other ways the system remained unchanged throughout the entire experiment.

Since the data is logged in terms of arbitrary numbers, conversion factors must be applied during read-out. The readings which have been analyzed and plotted in this report were converted through the use of the following factors:

Function Metered	Conversion Factor
Aural Power Output	One Division on chart = 1 percent
Aural Plate Current	One Division on chart = .0284 amperes
Aural and Visual Plate Voltage	One Division on chart = 57 volts
Visual Plate Current	One Division on chart = .024 amperes
Visual Power Output	One Division on chart = 1 percent

It should be recognized that the logging of arbitrary numbers along with the use of conversion factors utilizing a numerical division of such small magnitude is extremely difficult.

STUDIO MONITORING

Off-the-air studio monitoring was accomplished by feeding the output of the Conrac receiver into a Master Monitor at the remote control location. Characteristics of the visual signal could then be observed on the picture monitor and the cathode-ray oscilloscope. Such measurements as the amplitude of synchronizing pulses, depth of modulation, and set-up could, through this system of monitoring, be easily made.

By feeding the output from an external "chopper" into the Conrac receiver, reference white level was also displayed. This required the actuation of a switch located on the Master Monitor. Upon observing the video signal in this manner any corrective measures or adjustments could be made at the remote control point to insure that the characteristics of the transmitted signal complied in all respects with the Commission's technical requirements.

COMPARISON OF REGULAR AND REMOTE METER READINGS

In the following graphs, the automatically logged remote control readings are compared to the readings taken manually and recorded in the transmitter log. The graphs shown herein are a representative sampling of the data obtained from the four-month experiment.

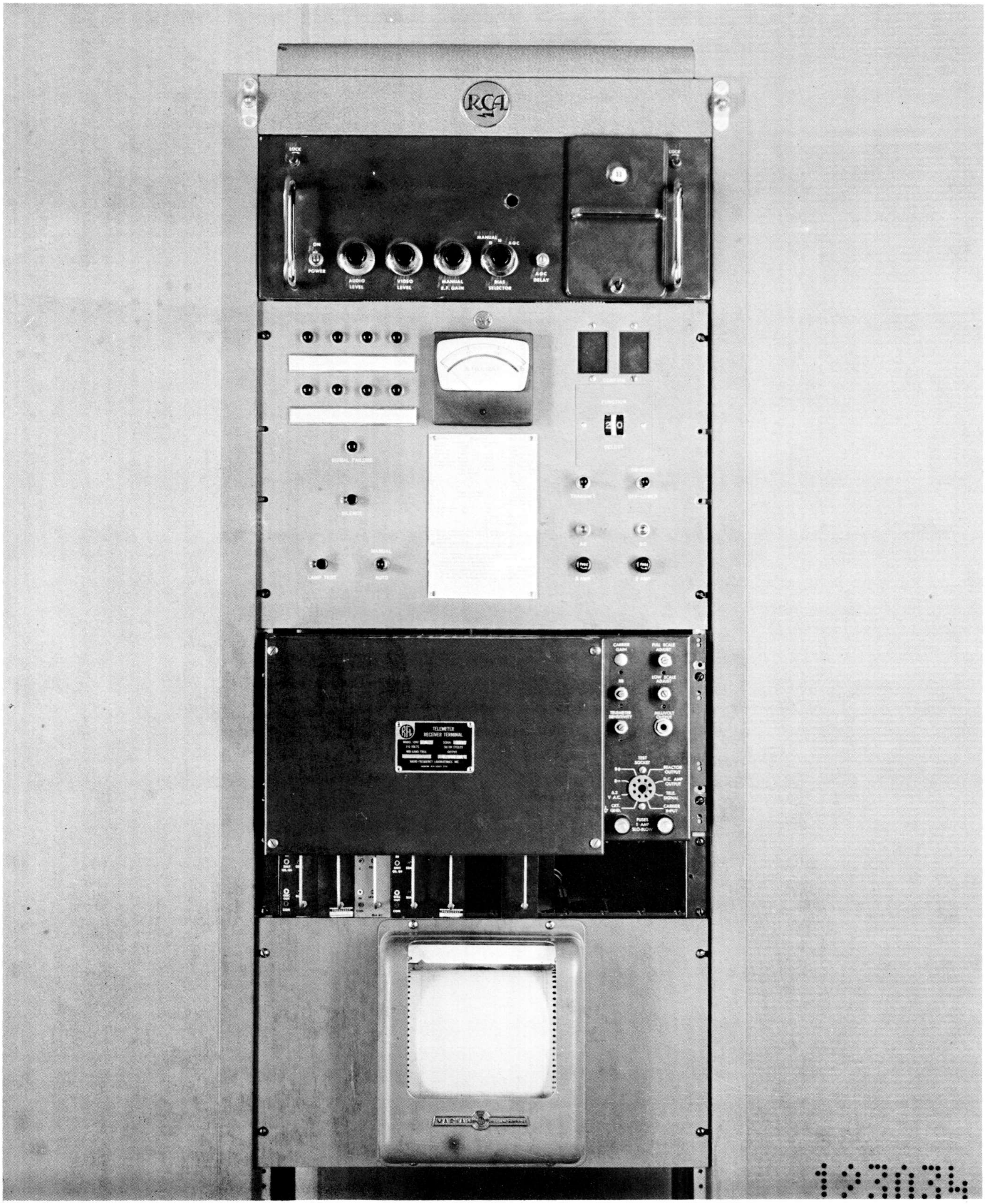


Figure #2 - Photograph of remote control system located at KKTV Studio. Individual units identified from top to bottom are 1) FSK transmitter feeding subcarrier to aural STL; 2) Control, alarm and manual meter readout; 3) FSK receiving terminal; 4) automatic logger.

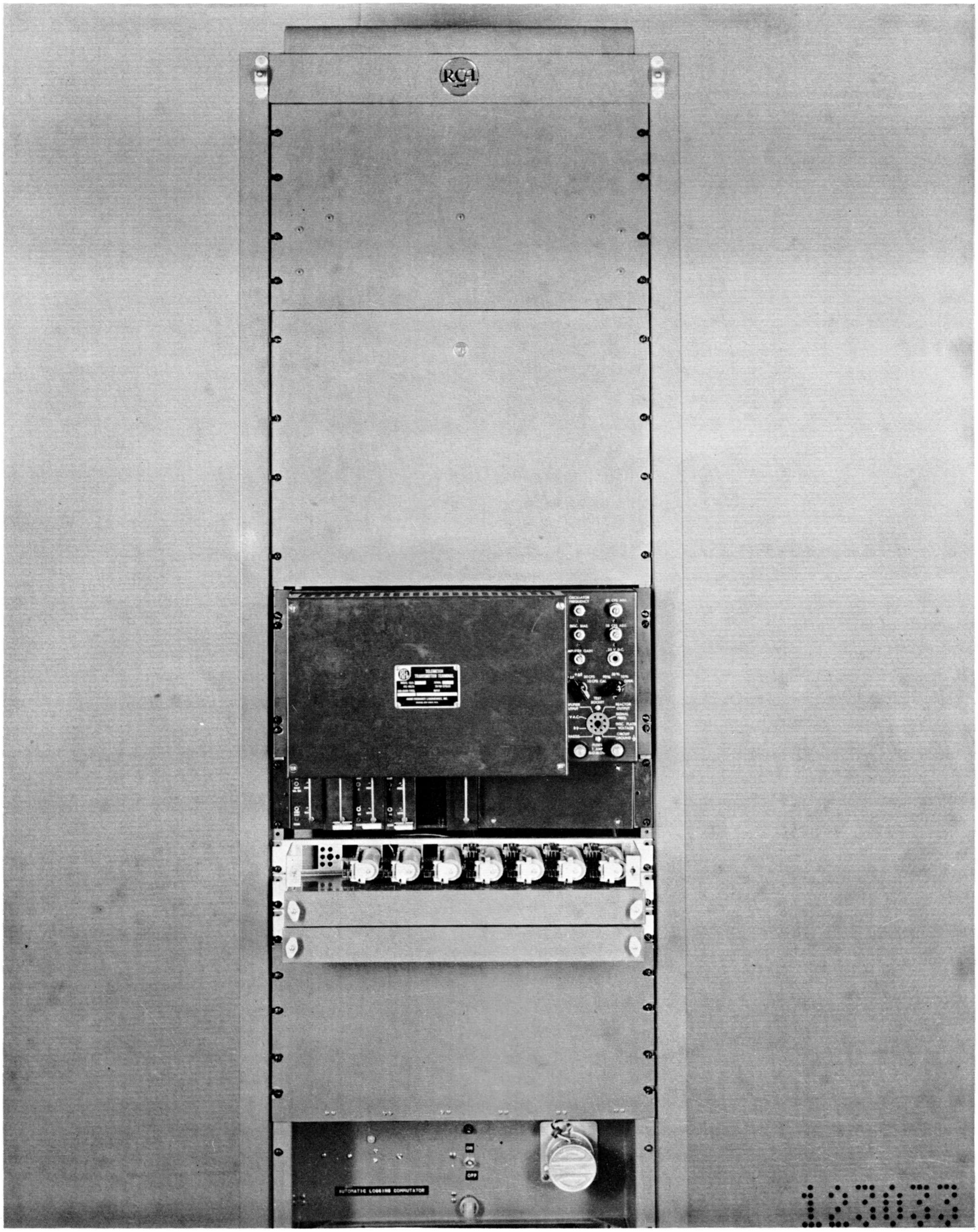
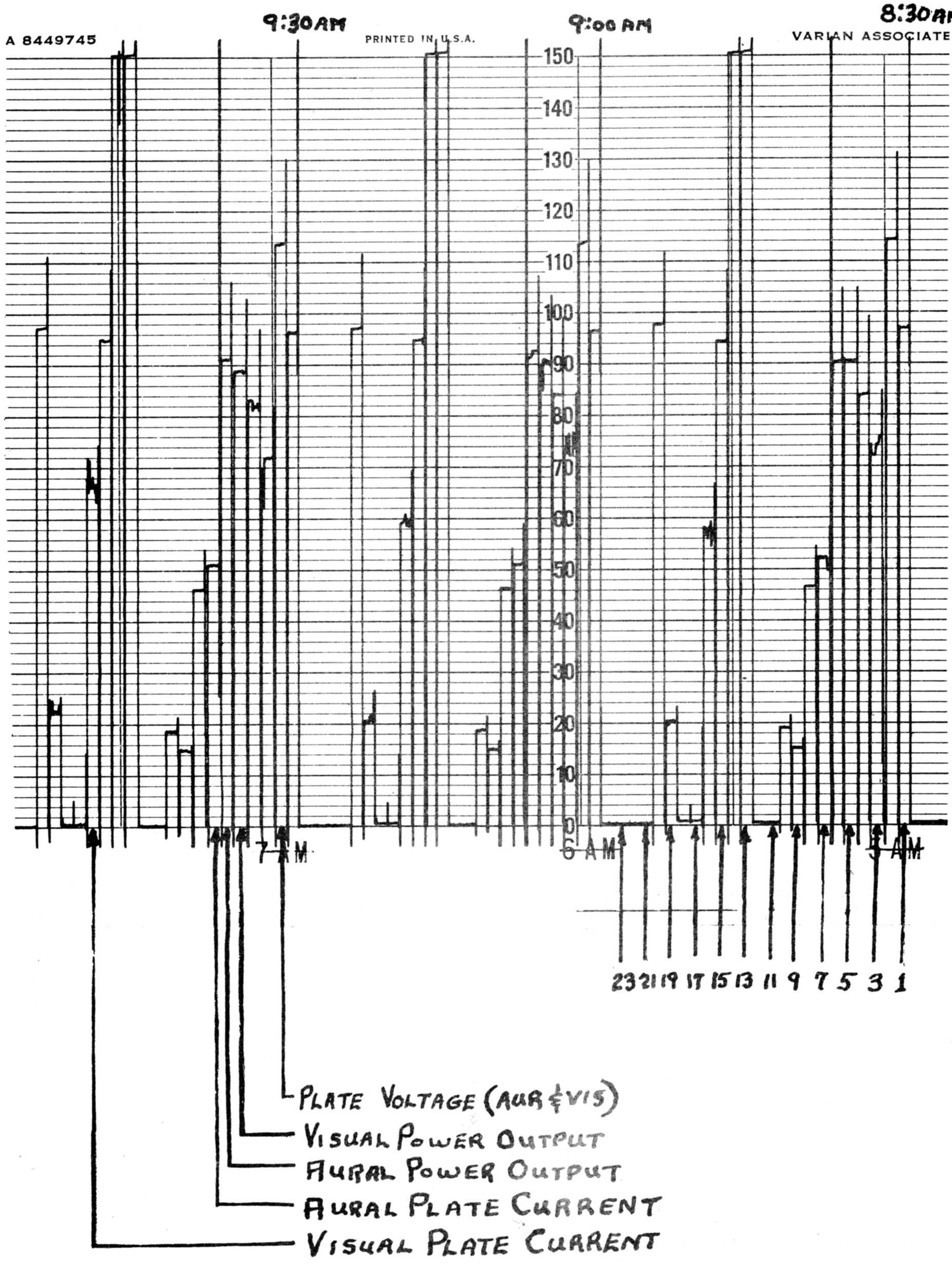
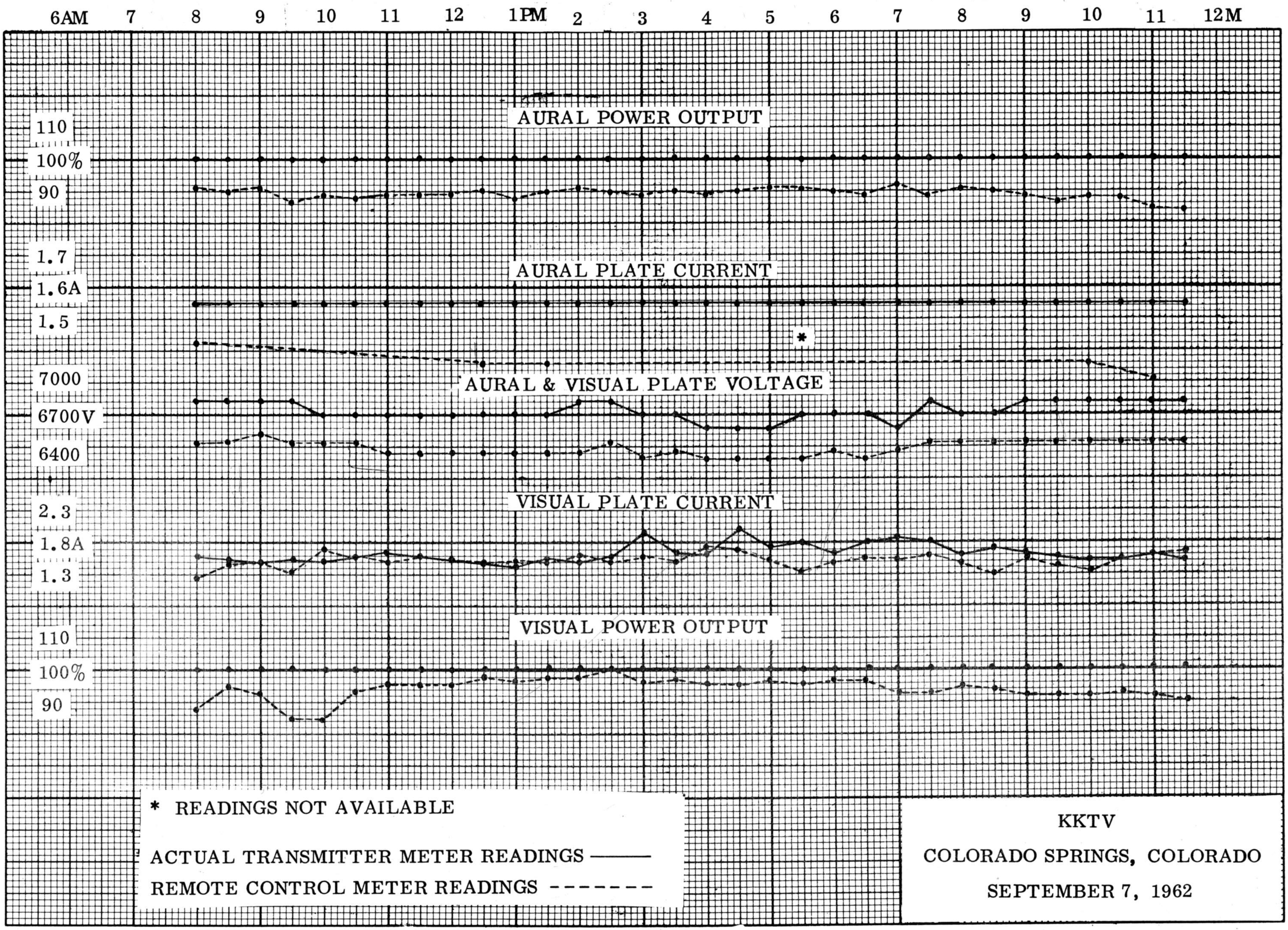


Figure #3 - Photograph of remote control system located at KKTV transmitter. Individual units identified from top to bottom are 1) Auxillary control relays; 2) Binary scanner; 3) FSK receiver and transmitter; 4) Transmitter control relays; xxx 5) Auxillary monitoring panel; 6) Automatic logging xxxxxx comutator.

SAMPLE OF AUTOMATIC LOG
RECORDING

Taken from Tape of September 27, 1962

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AURAL POWER OUTPUT
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AURAL PLATE CURRENT
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1.5
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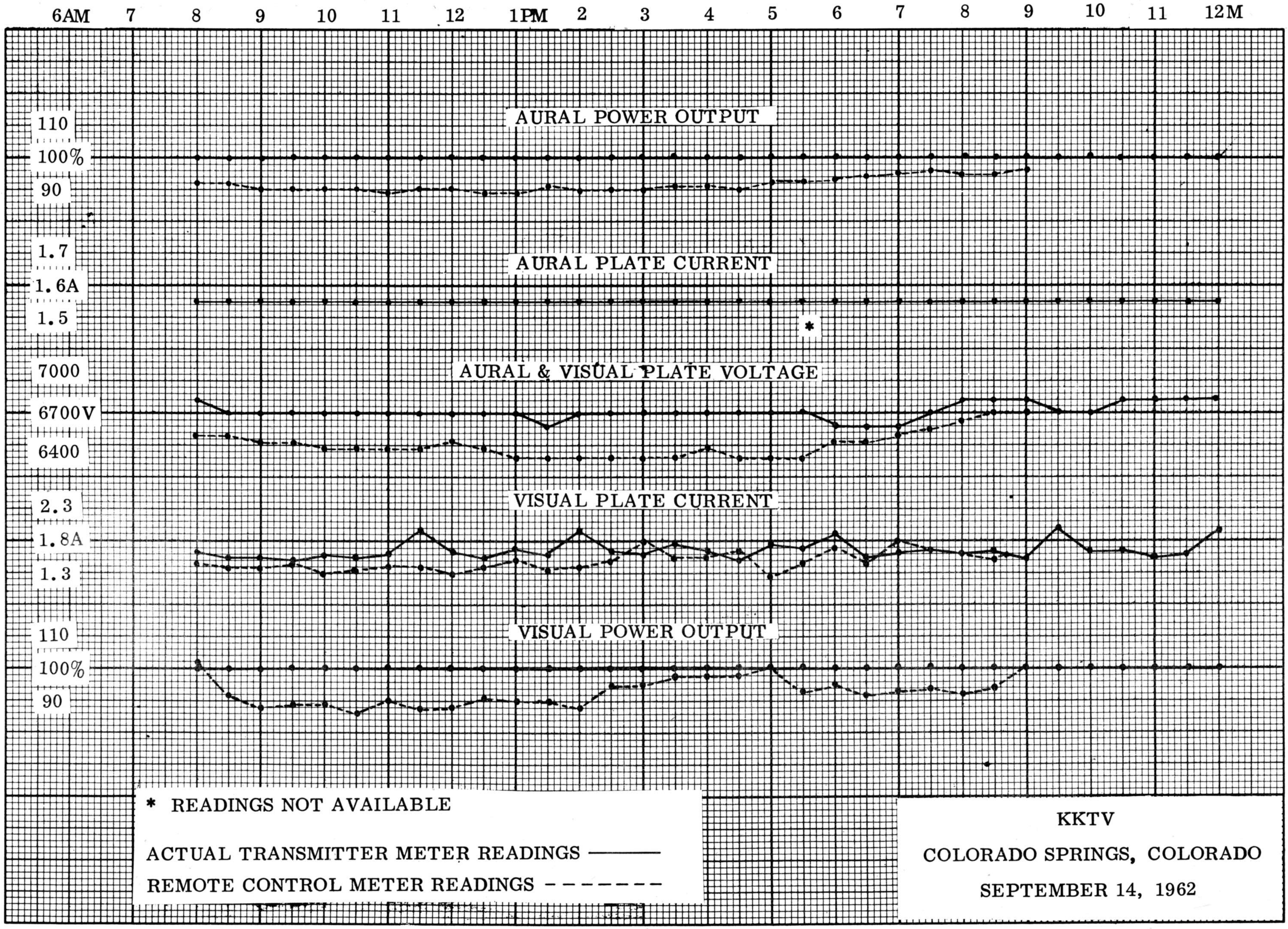
AURAL & VISUAL PLATE VOLTAGE
7000
6700V
6400
VISUAL PLATE CURRENT
2.3
1.8A
1.3
VISUAL POWER OUTPUT
110
100%
90
* READINGS NOT AVAILABLE
ACTUAL TRANSMITTER METER READINGS ————
REMOTE CONTROL METER READINGS - - - - - - -
KKTV
COLORADO SPRINGS, COLORADO
SEPTEMBER 7, 1962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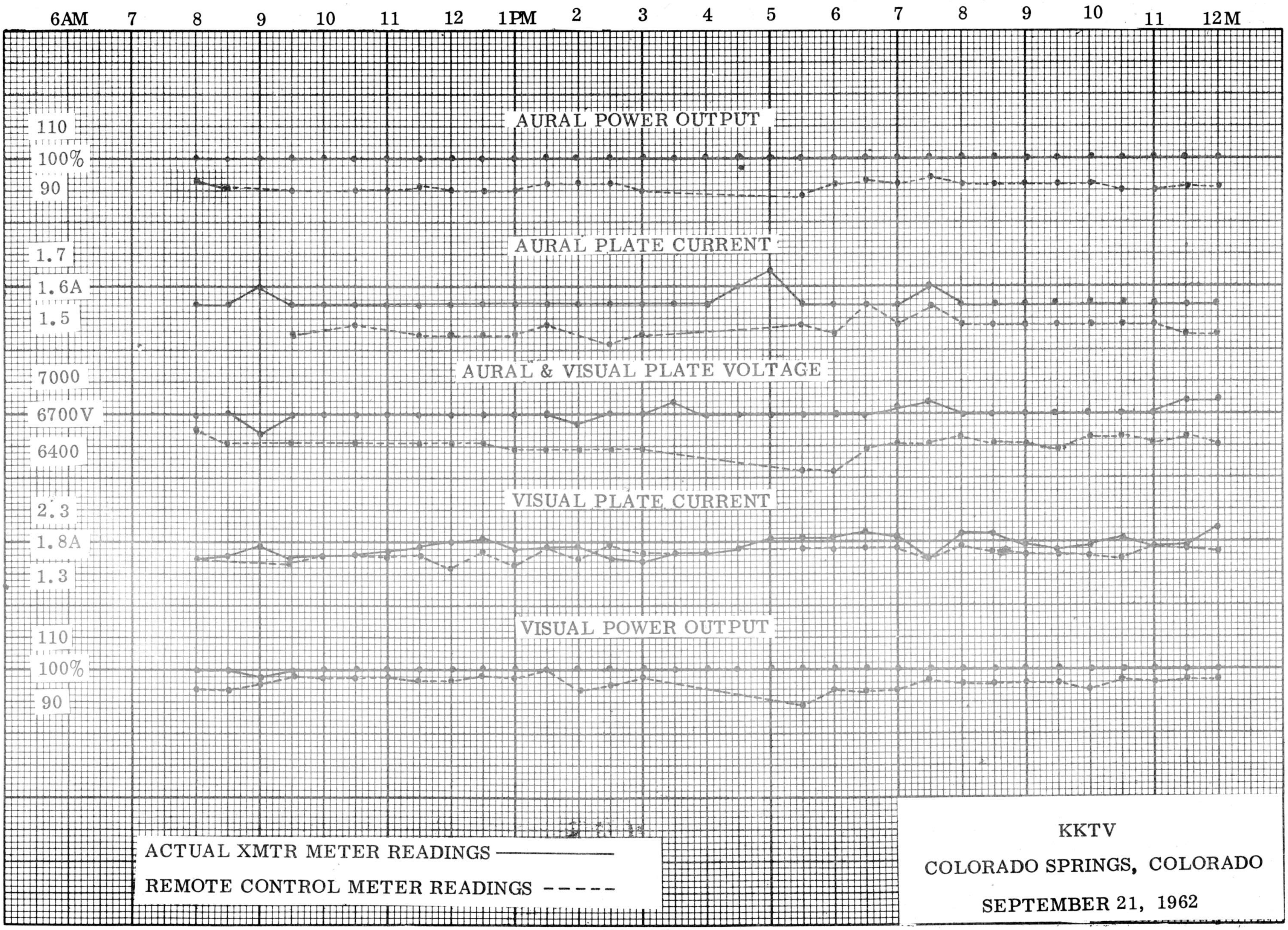
ACTUAL TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
KKTV
COLORADO SPRINGS, COLORADO
SEPTEMBER 14, 1962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ACTUAL XMTR METER READINGS ————
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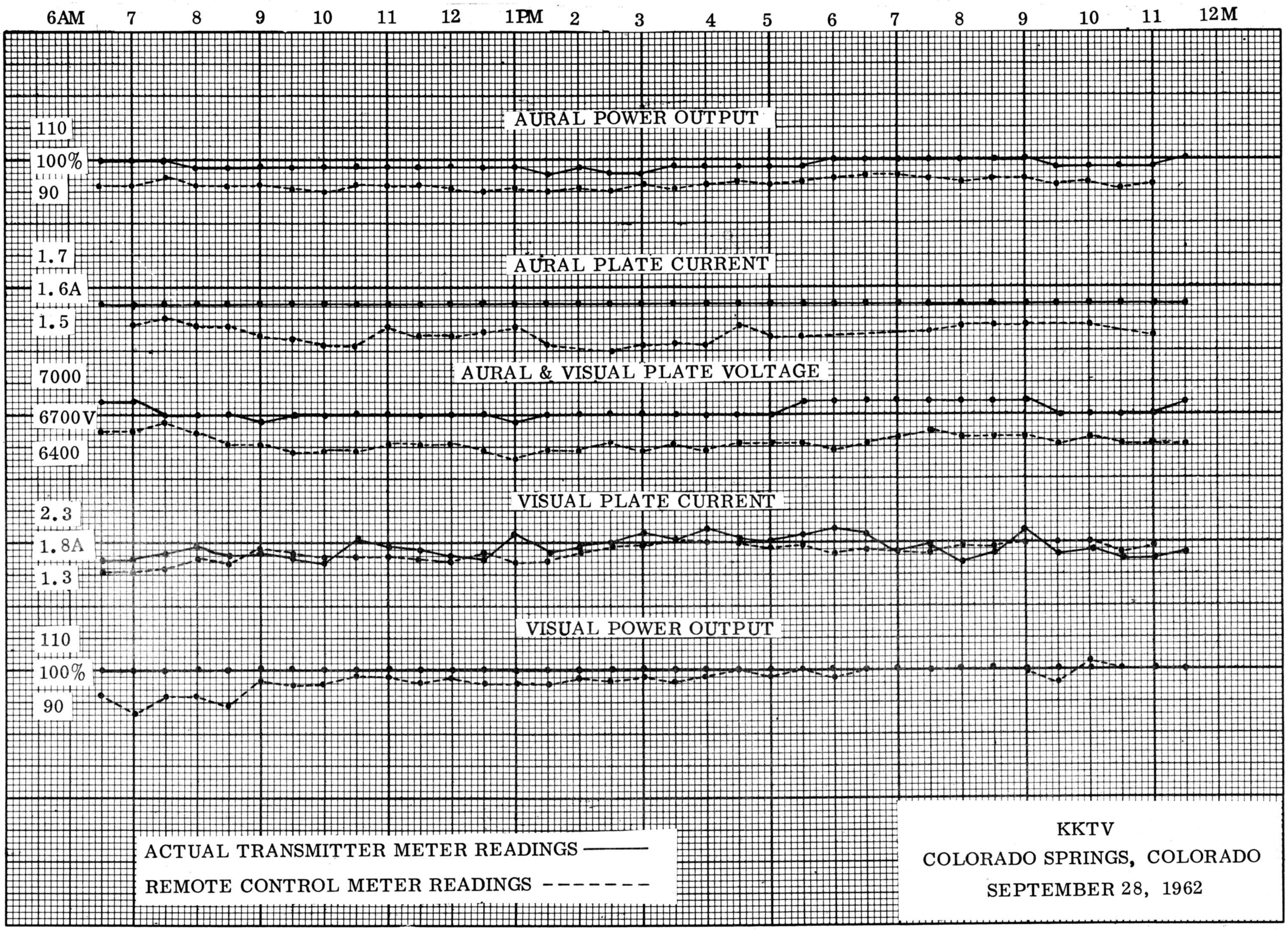
COLORADO SPRINGS, COLORADO
SEPTEMBER 21, 1962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REMOTE CONTROL METER READINGS
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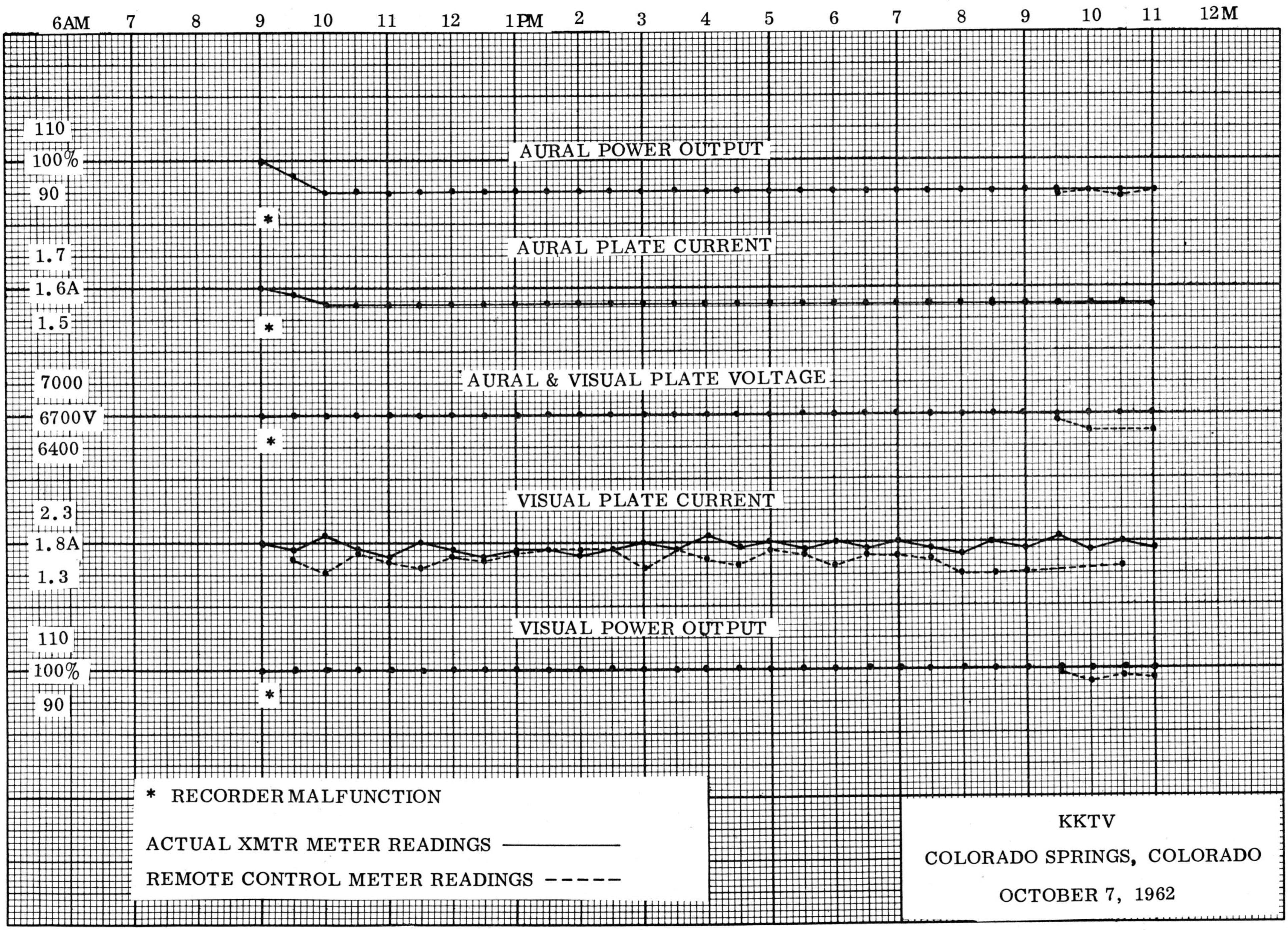
COLORADO SPRINGS, COLORADO
SEPTEMBER 28, 1962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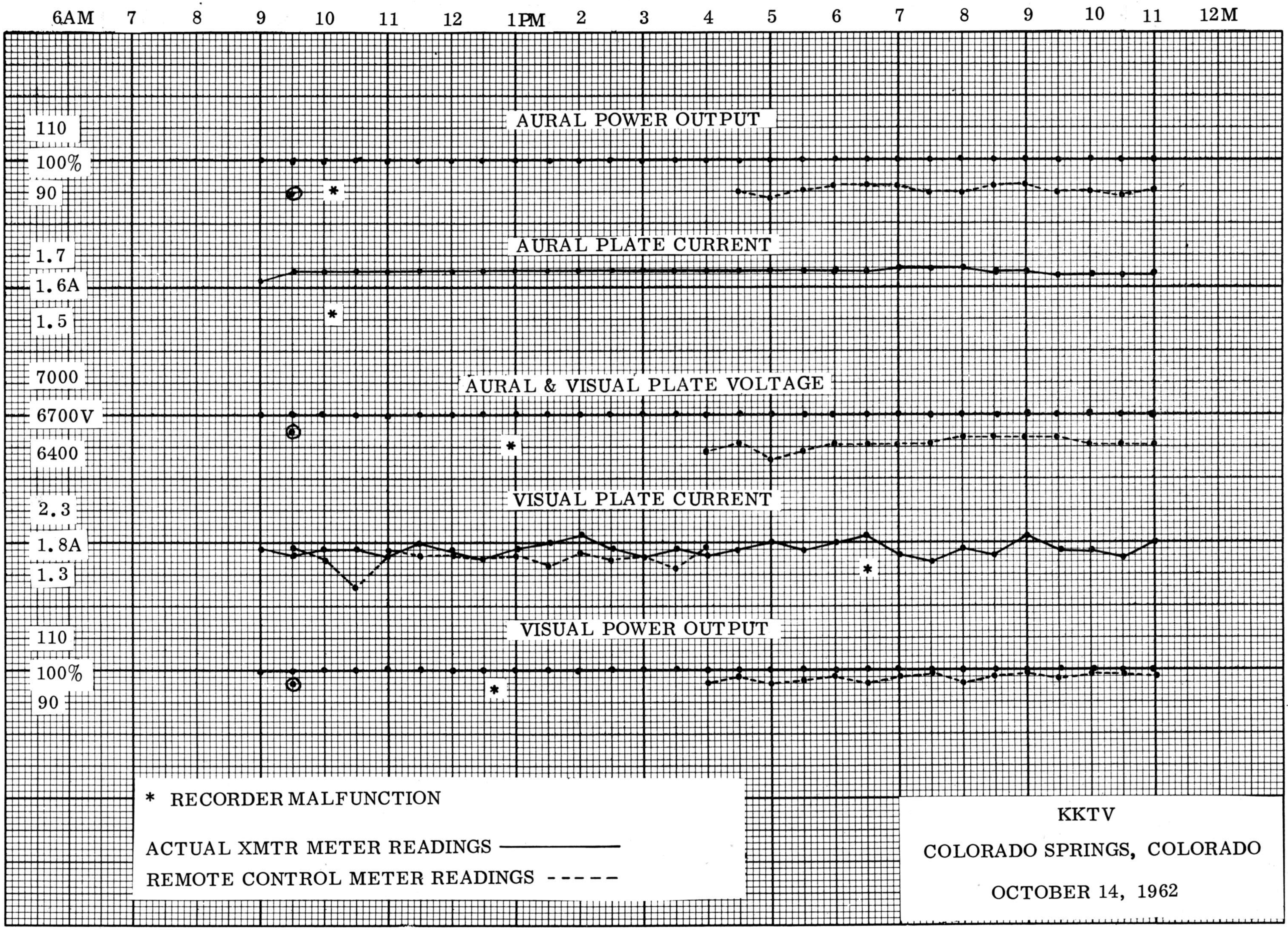
* RECORDER MALFUNCTION
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KKTV
COLORADO SPRINGS, COLORADO
OCTOBER 7, 1962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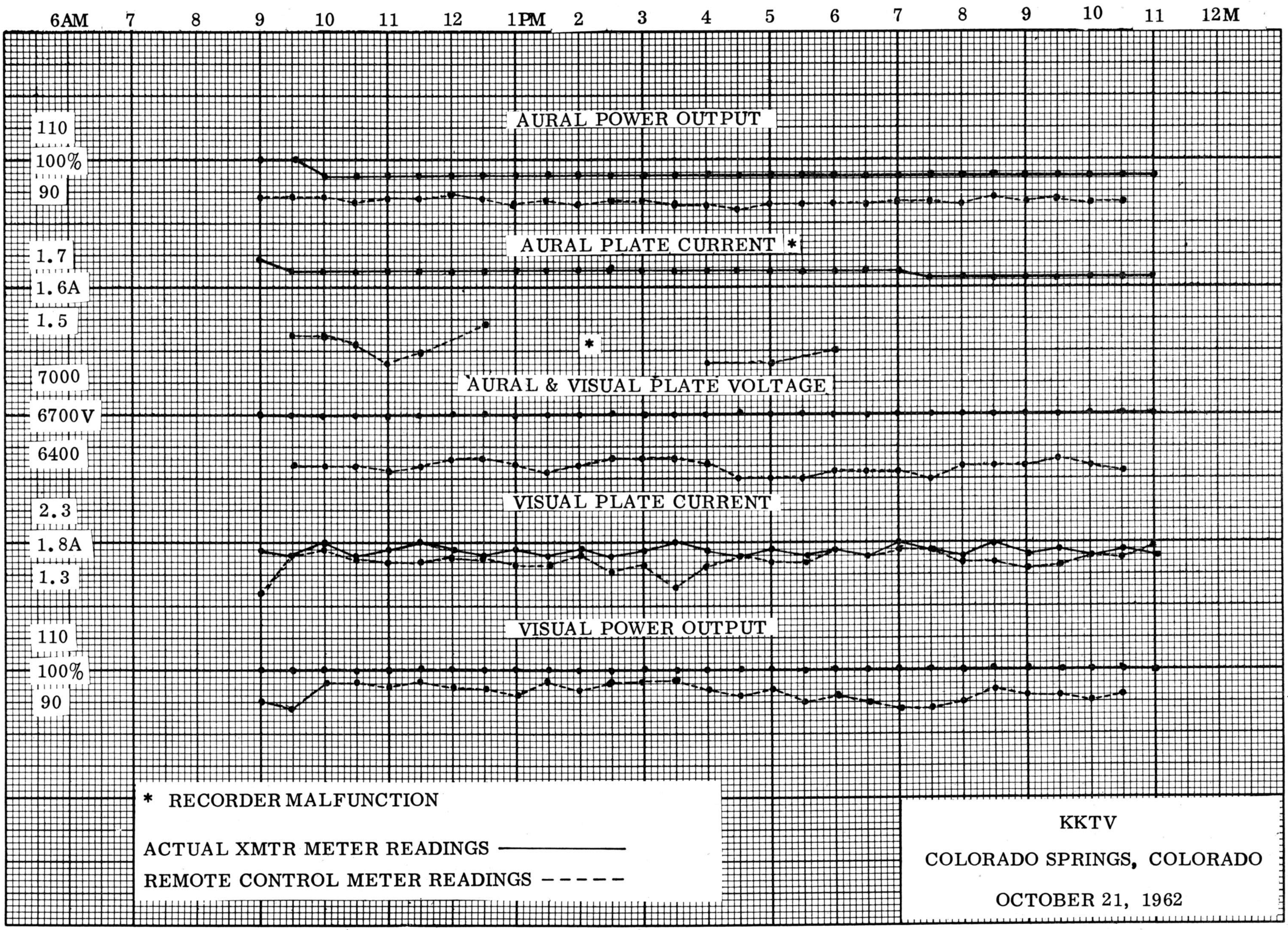
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS - - - - -
KKTV
COLORADO SPRINGS, COLORADO
OCTOBER 14, 1962



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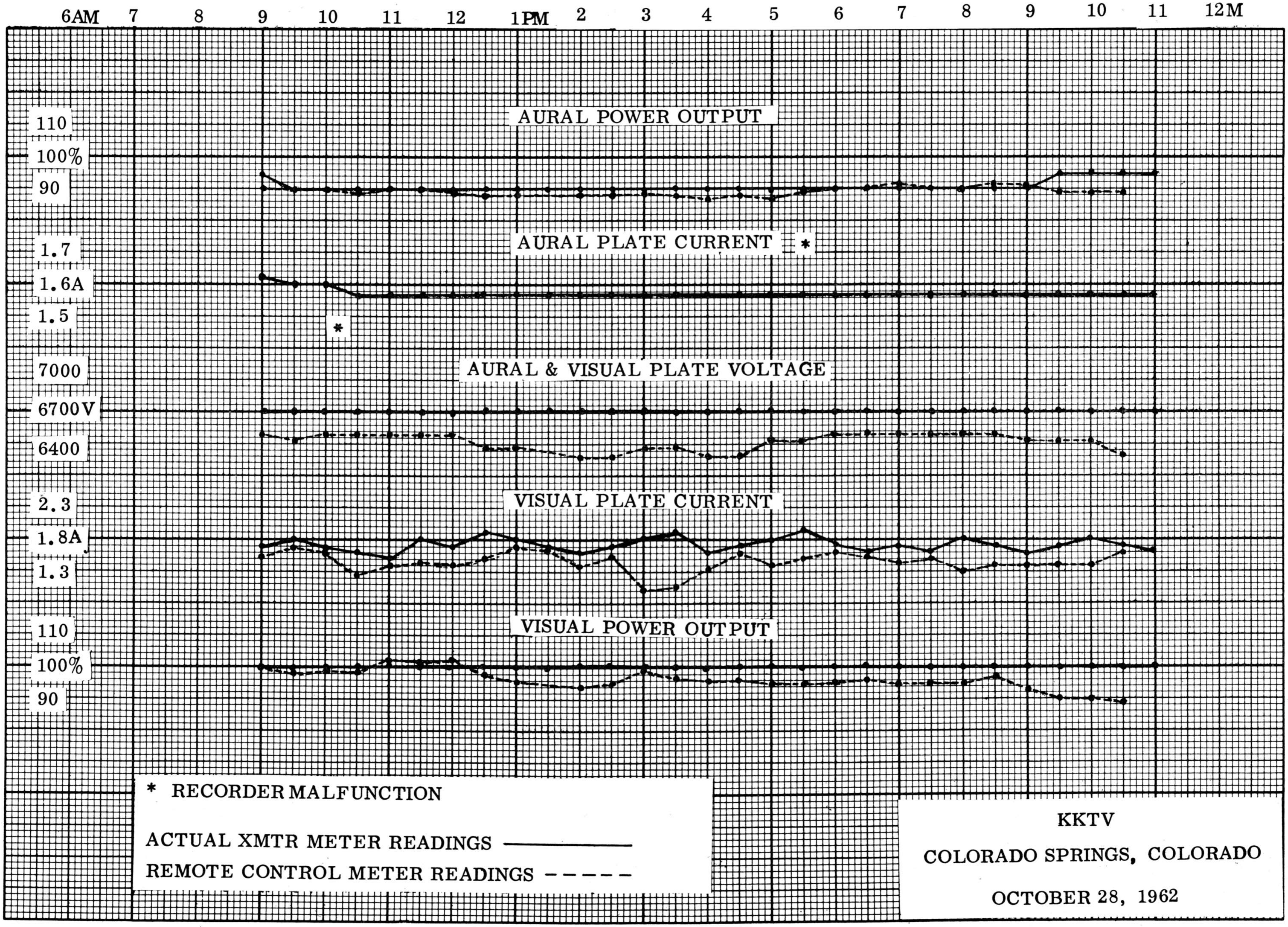
KKTV
COLORADO SPRINGS, COLORADO
OCTOBER 21, 1962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REMOTE CONTROL METER READINGS
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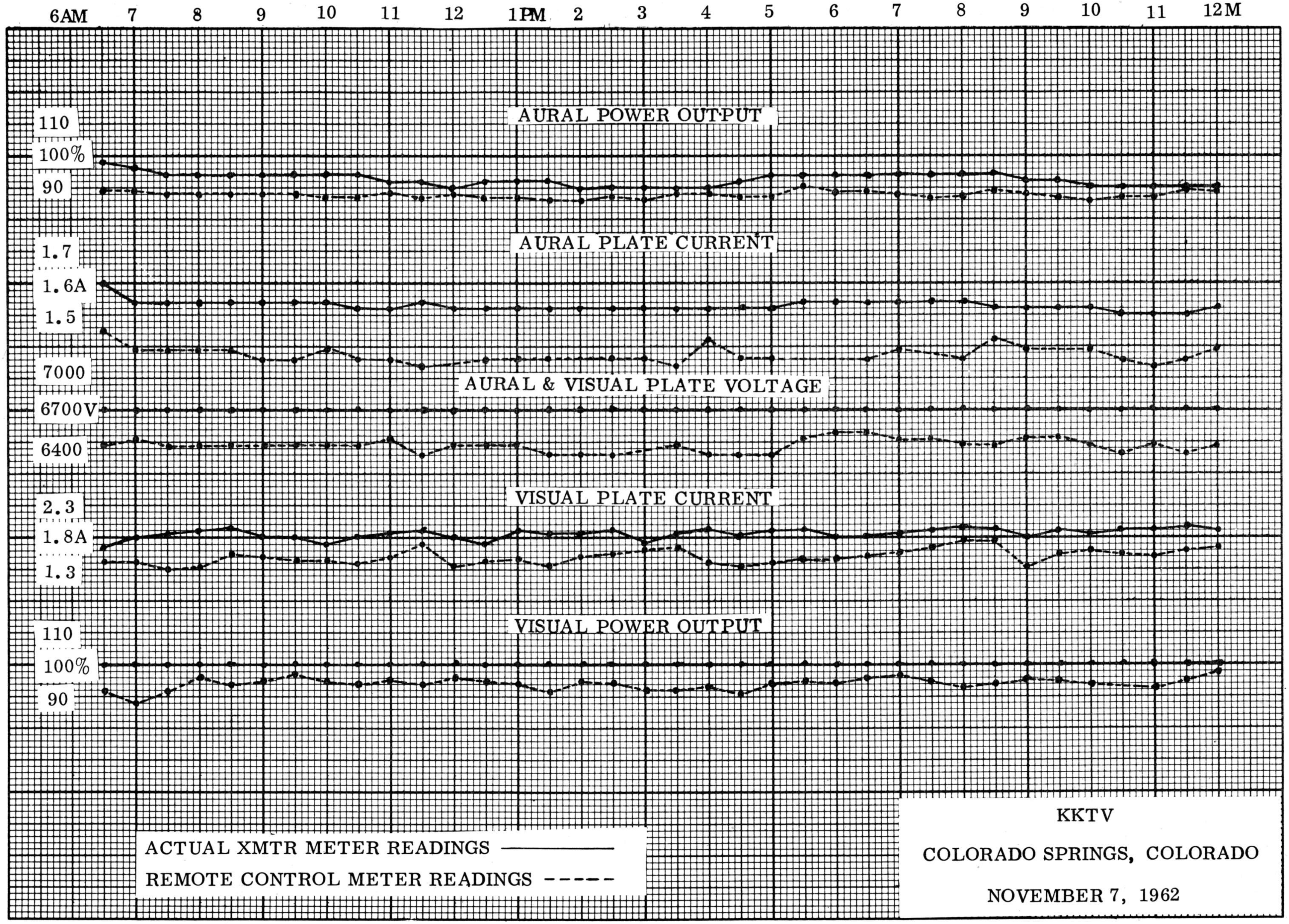
COLORADO SPRINGS, COLORADO
OCTOBER 28, 1962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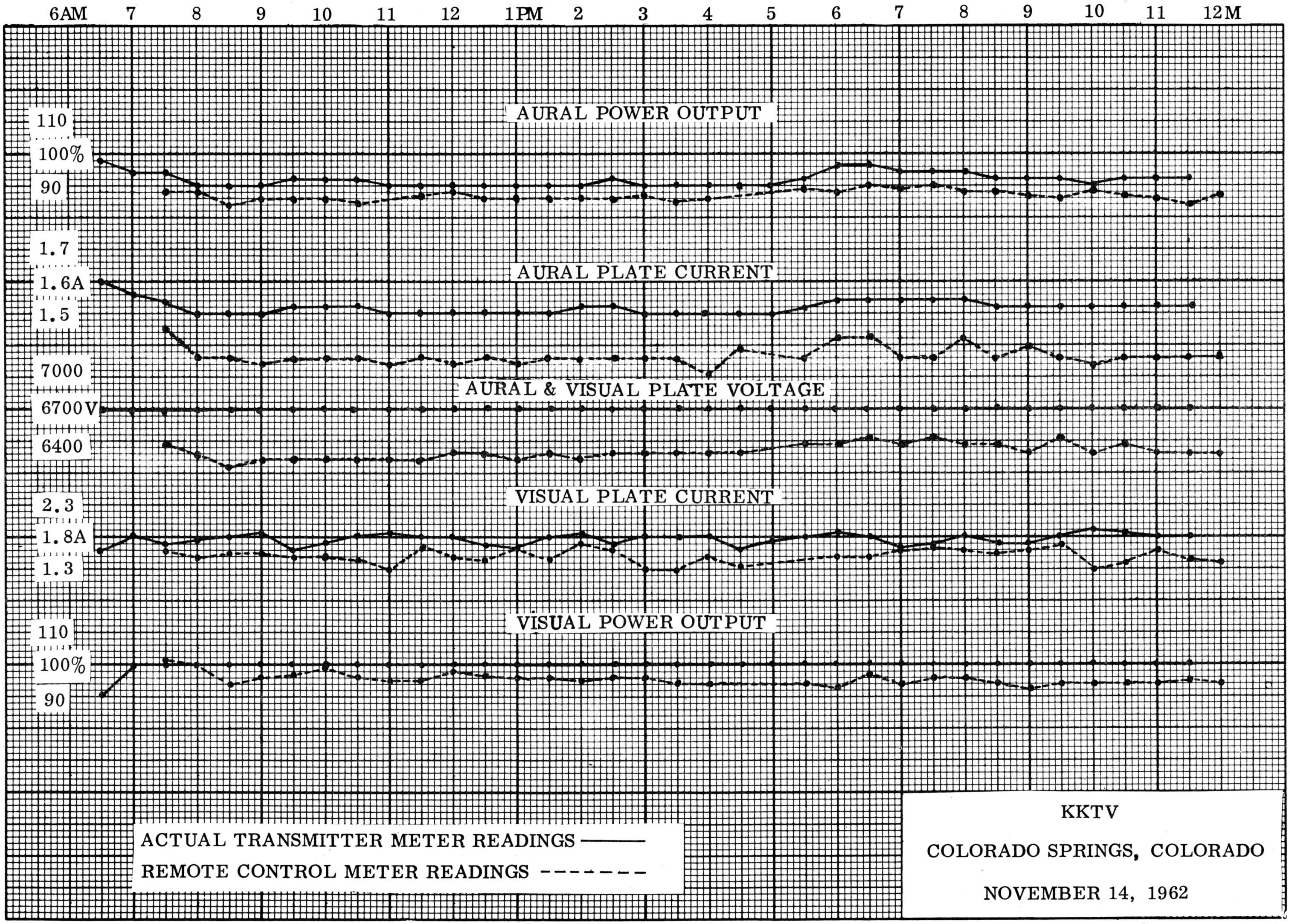
COLORADO SPRINGS, COLORADO
NOVEMBER 7, 1962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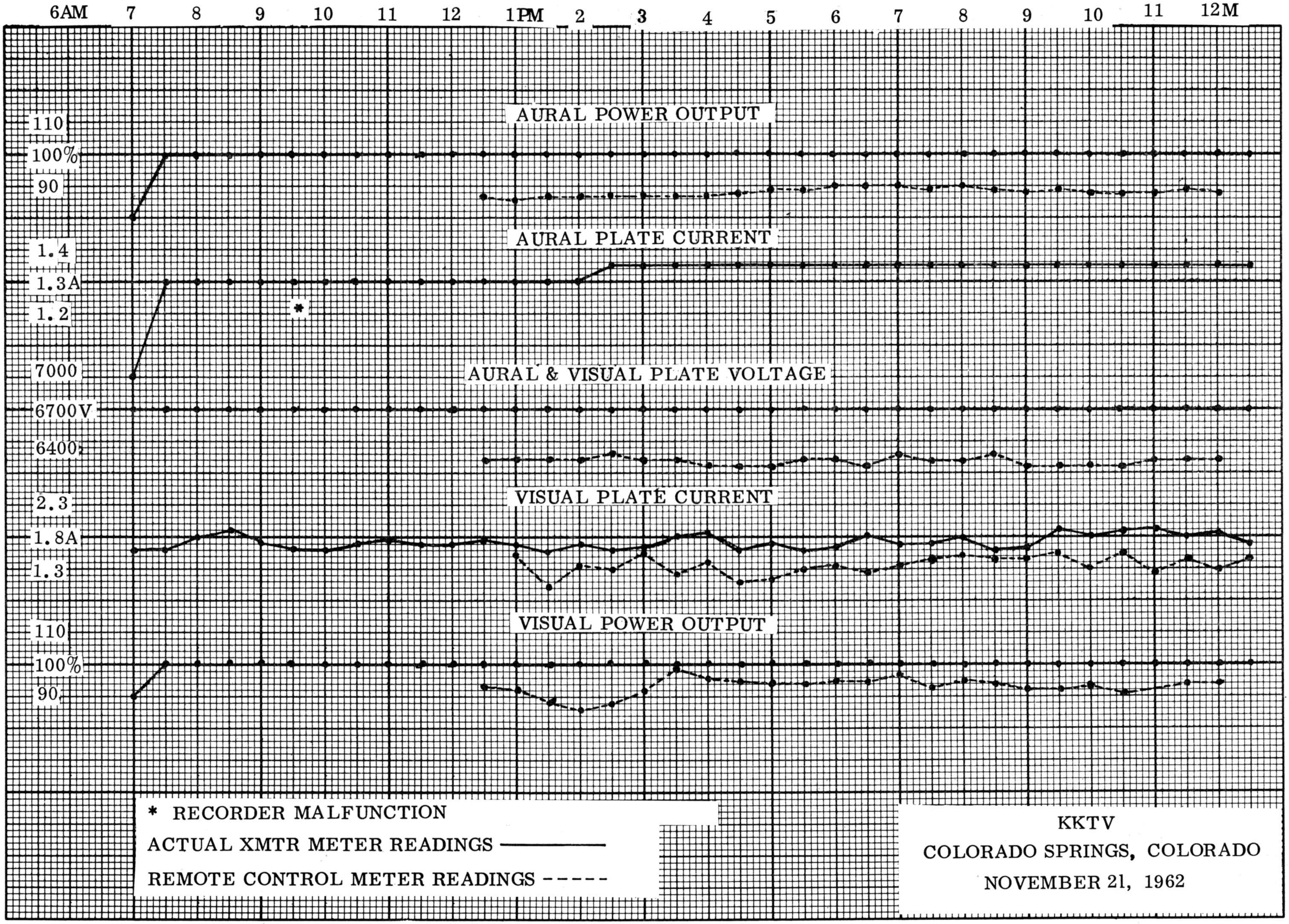
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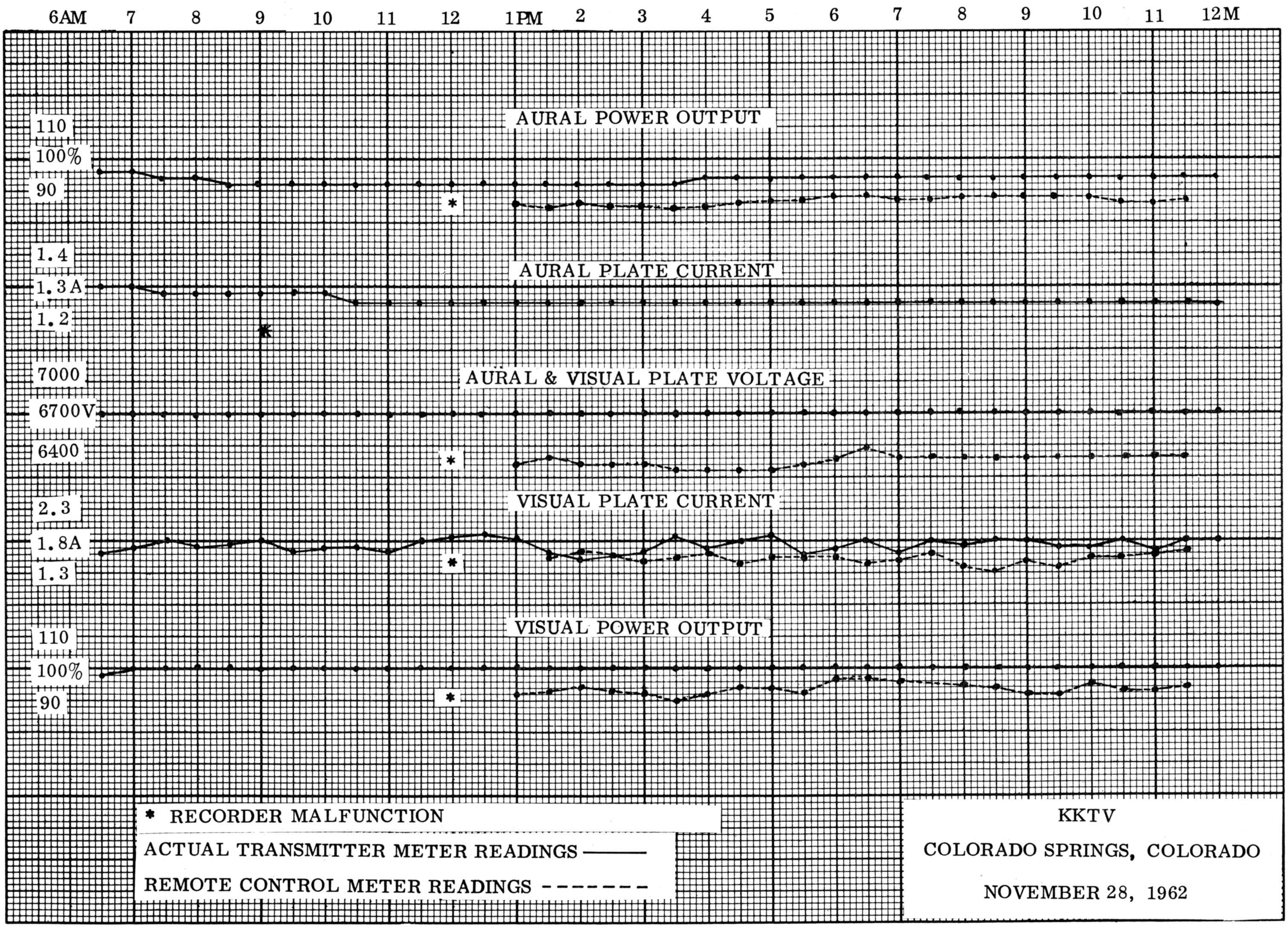
COLORADO SPRINGS, COLORADO
NOVEMBER 21, 1962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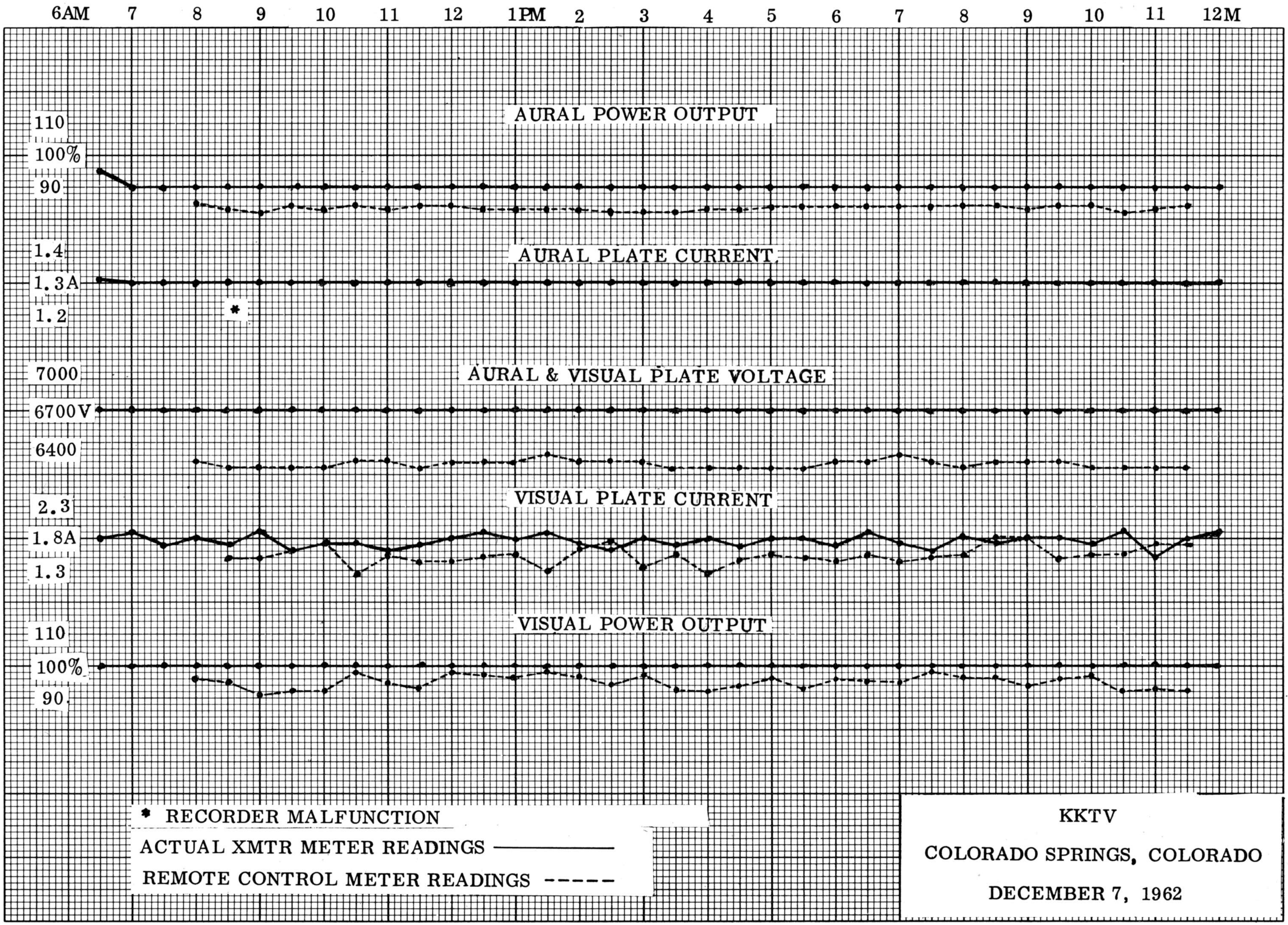
KKTV
COLORADO SPRINGS, COLORADO
NOVEMBER 28, 1962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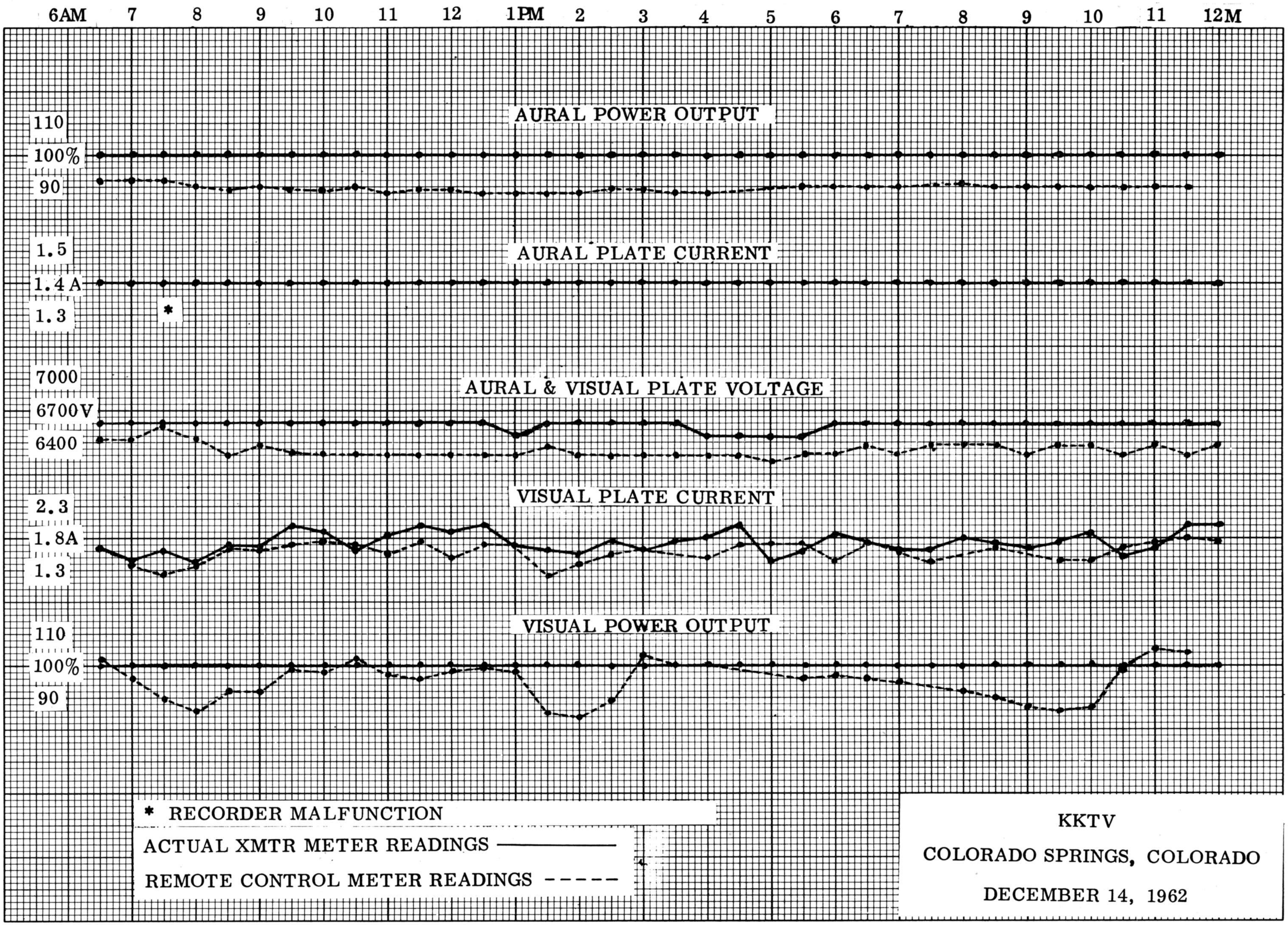
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KKTV
COLORADO SPRINGS, COLORADO
DECEMBER 7, 1962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REMOTE CONTROL METER READINGS
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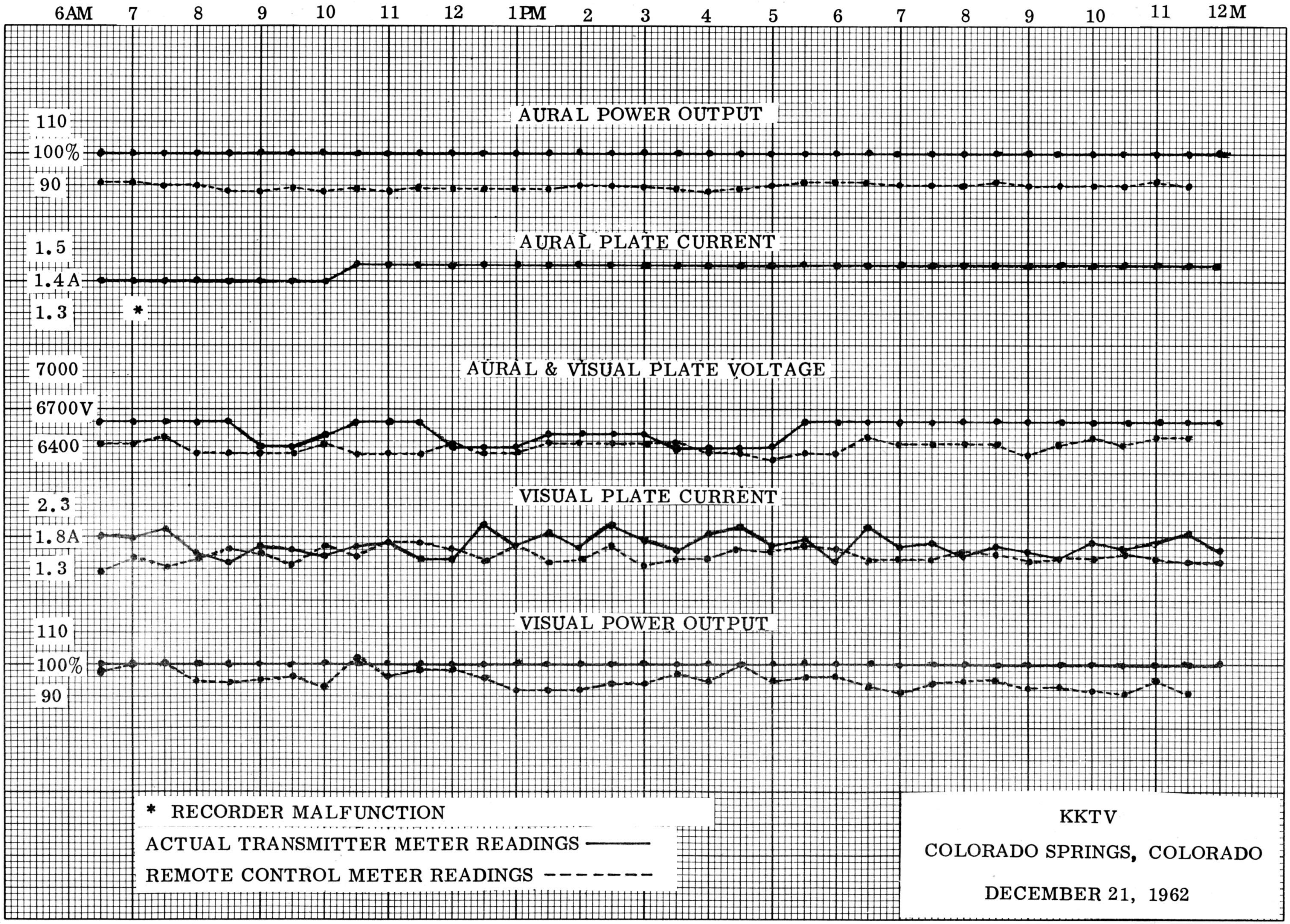
COLORADO SPRINGS, COLORADO
DECEMBER 14, 1962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VISUAL POWER OUTPUT
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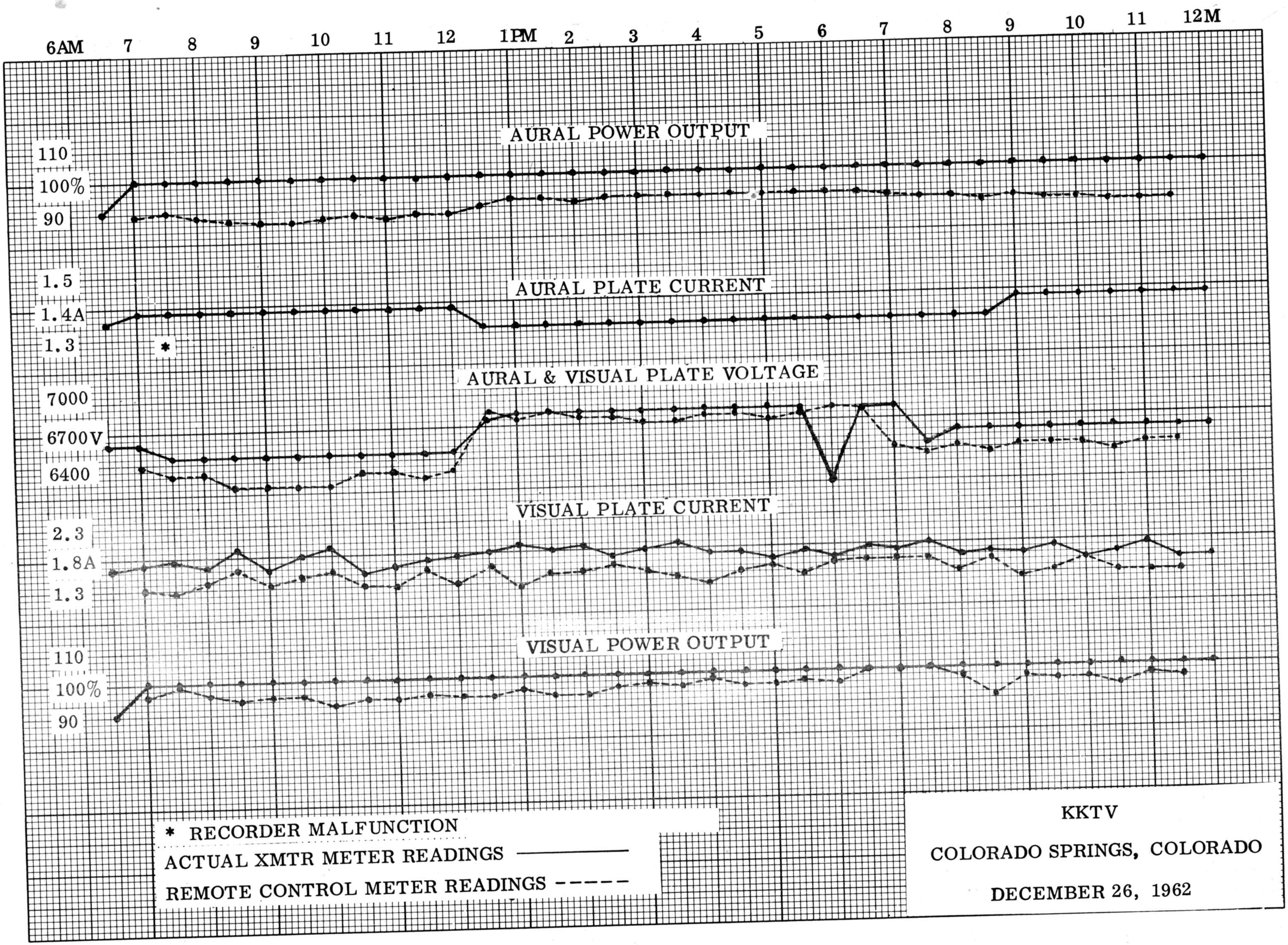
ACTUAL TRANSMITTER METER READINGS ———
REMOTE CONTROL METER READINGS - - - - - - -
KKTV
COLORADO SPRINGS, COLORADO
DECEMBER 21, 1962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* RECORDER MALFUNCTION
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KKTV
COLORADO SPRINGS, COLORADO
DECEMBER 26, 1962

SUMMARY OF RESULTS OF KKTV REMOTE CONTROL EXPERIMENT

The remote control tests at KKTV were conducted over an eight-month period. During this time, the manual control, metering, and alarms operated trouble-free. Once the system had been properly installed and calibrated, the remote control functions operated faultlessly and the remote meter readings tracked reasonably with those readings taken manually at the transmitter.

However, problems developed with the ink and pen in the recorder due to the altitude and low humidity affecting the ink wetting vehicle. Also, the automatic logger metering system at times gave erratic readings due to dirt accumulating on the sequential commutator. These problems associated with the performance of the automatic logger were not completely corrected during the period in which the tests were reported although several units were tried. A simple solution would have been to gold plate and hermetically seal the commutator keys and relays associated with the automatic logger and to change the recorder to use pressure sensitive chart paper, thereby eliminating the ink problem. Since this test was designed to prove the feasibility of remotely controlling VHF-TV transmitters the replacement of the logger was not deemed necessary. It is important to note, however, that

manual read-out of all metering functions is possible if for any reason they should fail to be recorded on the automatic logger.

The results of these tests at KKTV prove conclusively that a VHF-TV transmitter can be remotely controlled and logged without any sacrifice to equipment or technical performance. The equipment used in these tests is reliable and is flexible to a degree that the system can be contracted or expanded to meet the needs of any broadcaster.

REMOTE CONTROL EXPERIMENT

KFMB-TV

San Diego, California

INTRODUCTION

Station KFMB-TV is licensed to the Transcontinent Television Corporation[1/] and operates on Channel 8, assigned to San Diego, California. The studios are located at Fifth and Ash Streets, San Diego, and the transmitter atop Mount Soledad (Coordinates N 32-50-17, W 117-14-56). The station is authorized to operate with a visual power of 245 kilowatts Effective Radiated Power at a height of 760 feet above average terrain.

The primary purpose of the KFMB-TV experiment was to establish the feasibility of utilizing slightly modified existing "off-air" remote control equipment in conjunction with a TV transmitter not specifically designed for remote control operation. The remote control system was supplied by the Moseley Associates, Inc. of Santa Barbara, California, manufacturers of FM multiplex remote control systems.

On June 25, 1962, station KFMB-TV received the following special Temporary Authorization from the Federal Communications Commission to conduct remote control experiments and, through subsequent extensions granted by the Commission, held such authorization until December 27, 1962.

1/ Since experiment, license has been transferred to Midwest Television, Inc.

". . . In order to conduct experimental remote control and telemetering utilizing facilities of Station KFMB-TV during regular program operation, temporary authority granted to multiplex subcarrier on TV STL Station KMQ-50 consisting of Station KFMB-TV transmitter remote control signals. Also temporary authority granted to multiplex a subcarrier on KFMB-TV aural transmitter consisting of telemetering signals. Above non-standard transmissions shall be in exact accordance with the engineering specifications contained in the engineering report accompanying your request. Regular operators as prescribed by Section 3.661 Rules shall be in full control of KFMB-TV transmitter and normal logs as prescribed by Section 3.663 Rules shall be maintained at all times KFMB-TV is operated. The Commission shall be furnished with a written report of performance and observations of experimental operation at conclusion of authorization. This authority expires September 25, 1962 unless sooner terminated at discretion of the Commission. Consideration will be given to request for extension timely filed with regard to circumstances then prevailing. The Commission shall be advised when operation commences under this authority."

The holder of a First-Class Radiotelephone license was present at the transmitter during all periods of operation as required by Section 73.661 of the Commission's Rules. A regular transmitter log was maintained and the transmitter was under the immediate supervision of the First-Class license holder at all times. A telephone talkback circuit was provided between the transmitter and studio (remote control point) and a continuous check was made on the operation of the system.

DESCRIPTION OF TRANSMITTER

KFMB-TV employs an RCA Type TT-25BH transmitter with a visual output power of 23.4 kilowatts and the aural output power of 11.7 killowatts.

The amplifier consists of an air-cooled linear broad-band amplifier for the visual carrier, and air-cooled class "C" amplifiers for the aural carrier. Each amplifier consists of a single power stage utilizing a cluster of seven air-cooled triodes in a grounded-grid circuit. Diode monitors are included so that tuning and monitoring may be accomplished at both the input and output levels. A reflectometer is included for both the aural and the visual transmitters. This unit is designed to directly read percent deviation from assigned power, and standing wave ratio. The control equipment is of conventional design.

Since no provisions for remote control are incorporated in the transmitter, certain modifications were made to the equipment. These modifications, described later in this report, in no way affected the overall operation or technical performance of the transmitter.

REMOTE CONTROL SYSTEM

Introduction

Moseley Associates, of Santa Barbara, California, was selected to be the supplier of the KFMB-TV remote control equipment due to its proximity to

the station. This concern is in the business of manufacturing broadcast equipment and has produced multiplex remote control equipment for FM broadcasting for a number of years.

The KFMB-TV system consisted basically of a modified Moseley Model RRC-10 Radio Remote Control System. This system has particular application to remotely controlled transmitters where wire line control circuits are unreliable, expensive or nonexistent. It normally employs a studio-transmitter link operating in the 942 - 952 mc/s band for relaying the program, control tones, and subcarriers to the remote location. Relaying the metering information back to the remote control point is accomplished by an SCA subcarrier multiplexed on the main FM channel.

The first such system was installed in November, 1959, and has been in continuous service since that date. Numerous other systems of the same type are presently in use, and, to the knowledge of the manufacturer, the unit has been free of major problems, with maintenance consisting only of periodic tube checks.

Since it was not the purpose of this particular test to incorporate the read-out of monitoring equipment at the remote location it was felt that the Model RRC-10 would lend itself very ably to the task set forth, with the simple addition of several pieces of auxiliary equipment.

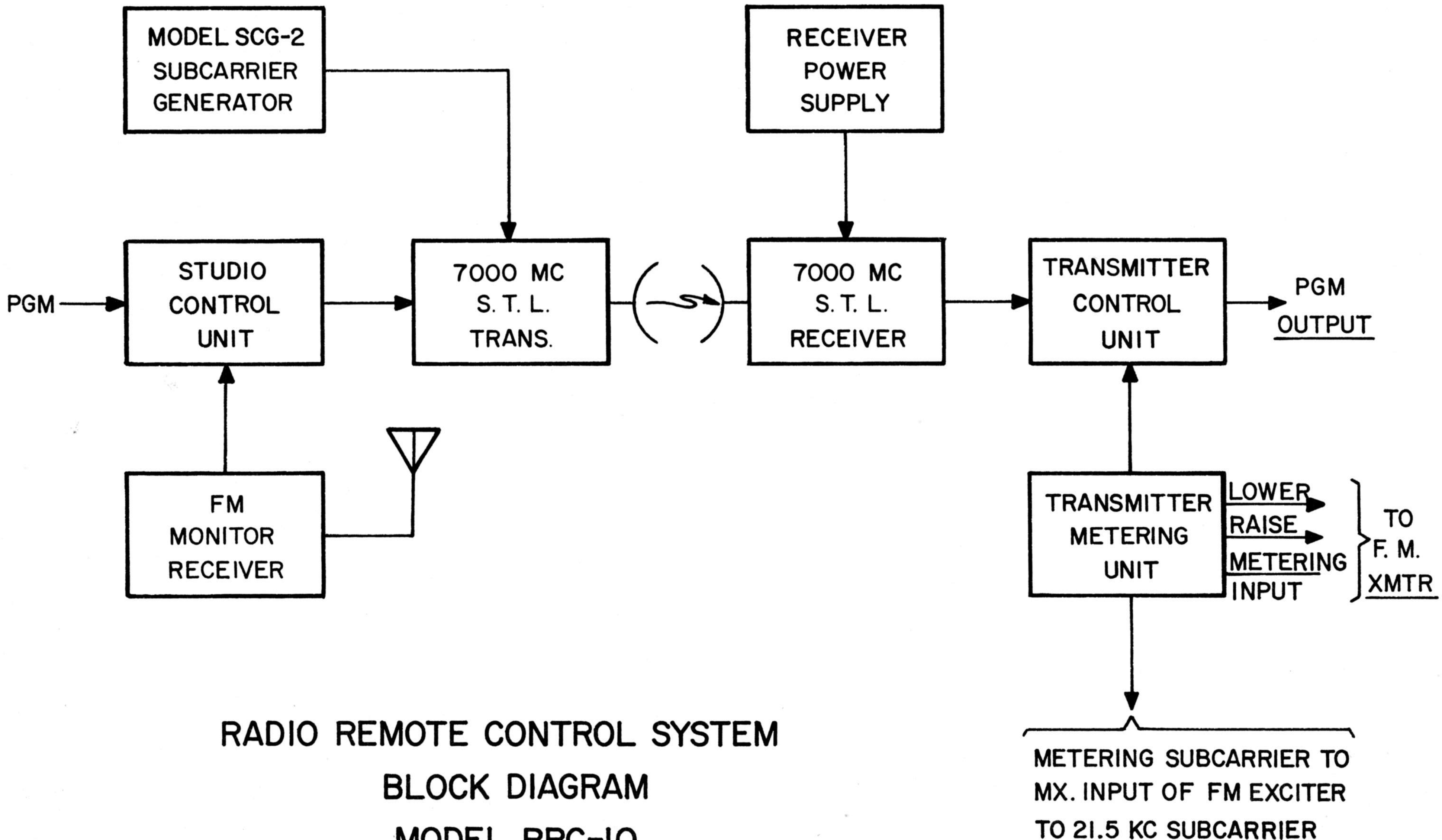
Description of Equipment

The Model RRC-10 Radio Remote Control System consists of the following three basic units:

1. Studio Control
2. Transmitter Control
3. Transmitter Metering

The first unit is located at the studio and contains the control tone oscillators and telemetering demodulation circuitry. The latter two units are situated at the transmitter and provide for the detection of the control tones, relay operations, and telemetering functions. (See system block diagram).

As used in the FM service, the Model RRC-10 operates in conjunction with a 950 mc aural studio-transmitter-link (STL). The STL relays the main channel program to the remote transmitter along with the supersonic control signals generated by the Studio Control Unit. It is not necessary, however, that a 950 mc STL be employed. In the KFMB-TV installation the TV aural program is carried to the transmitting site on a subcarrier diplexed on the existing TV STL. The control tones are inserted into the aural subcarrier on the STL and recovered prior to the de-emphasis network in the 6.2 mc receiver. This technique permits the original outgoing control signals to be well below the main channel modulation; thus, the bandwidth of the audio subcarrier is not materially increased with the presence of the control tones.



RADIO REMOTE CONTROL SYSTEM
BLOCK DIAGRAM
MODEL RRC-10

Four control tones can be generated by the Studio Control Unit. They provide for the LOWER, RAISE, SWITCHING, and STEPPER/RESET controls, and operate in the 20 kc to 23 kc portion of the spectrum. The control oscillators are of the Hartley design and utilize stabilized toroidal inductors and silvered mica capacitors to insure frequency stability. The stability of this design has been proved by more than three years of continuous operation. The oscillator frequency is independent of tube replacement.

The STEPPER/RESET control tone operates a ten position, three level stepper switch at the transmitter site. A pulse duration technique is used to insure synchronization between the position of the stepper switch at the transmitter site and the position of the selector control at the studio. Two of the three levels on the transmitter stepper switch are wired in series with the RAISE and LOWER control circuitry. Thus, by initiating either the RAISE or LOWER oscillators, commands will appear at the output of the transmitter control unit on the barrier points determined by the stepper switch. In the third stepper position, for example, either a RAISE or LOWER command may be given. This operation can be repeated on any of the ten control positions. A 15 kc low-pass filter is included in the Studio Control Unit to remove any spurious signals which could interfere with the operation of the control circuitry. Similarly, a 15 kc low-pass filter is employed in the Transmitter

Control Unit to prevent the control tones from modulating the FM exciter of the TV aural transmitter.

Metering

Telemetering for the KFMB-TV test was accomplished by multiplexing a 21.5 kc subcarrier on the TV aural carrier with injection set to modulate the sound carrier at 10%. The exact frequency of the 21.5 kc subcarrier is controlled by the level of the dc sampling voltage obtained from the TV transmitter. Full metering range is obtained by shifting the subcarrier frequency between 21.5 kc and 21.9 kc. The third level of the ten position stepper switch selects which metering function is to be transmitted to the control center. To adapt the KFMB-TV transmitter for subcarrier operation, it was necessary only to inject the metering subcarrier after the audio input transformer on the Serrasoid modulator.

A Conrac receiver tuned to Channel 8 (KFMB-TV) was used at the studio to recover the 21.5 kc metering subcarrier. The signal was removed before the de-emphasis circuitry, applied to a tuned circuit, and then applied to the telemetering input on the Model RRC-10 Studio Control Unit. A high-pass filter and double tuned 21.5 kc resonant circuit detects the subcarrier. The signal is then passed through a two-stage limiting amplifier to a phase type discriminator for demodulation. Since the metering parameters being measured

are essentially static in nature, very little bandwidth is required for the metering signal. The output of the frequency discriminator is a dc voltage which represents the value of the function being metered. Three panel meters are employed on the Studio Control Unit, and the output of the discriminator is routed to the appropriate meter by a stepper switch synchronized with the remote stepper switch.

Installation

Figure 1 is a photo of the Studio Control Unit as installed in the KFMB-TV master control room. Mounted directly beneath the unit is the Conrac receiver used to recover the 21.5 kc subcarrier from the TV aural carrier. The 6.2 mc subcarrier transmitter is mounted above the unit. The audio program is first fed into a unity gain amplifier in the Studio Control Unit which contains a 15 kc low-pass filter. The four control tones are mixed with program signal after the filter. The composite output signal from the Studio Control Unit is then fed into the 6.2 mc subcarrier transmitter for relay to the TV transmitter site on a 7 kmc STL.

Due to the electrical noise level existing in the power lines in the studio, it was necessary to employ additional filtering in the Conrac receiver to prevent transient type noise from being applied to the limiters.

At the transmitter site the control tones are taken from the 6.2 mc receiver prior to de-emphasis and applied to the Transmitter Control Unit. Figure 2 shows the Transmitter Control and Metering Units mounted beneath the subcarrier receiver. A length of RG-58/U was connected between the 21.5 kc output of the Metering Unit and the FM exciter.

The following control and metering functions were performed:

Position No.	Control Function	Telemetering Information
1	ON-OFF Aural Carrier	Aural P.A. Volts
2	-	Aural P.A. Current
3	RAISE/LOWER Aural Power	Aural Power Output
4	-	Tower Lights
5	ON/OFF Visual Carrier	Visual P.A. Volts
6	-	Visual P.A. Current
7	RAISE/LOWER Visual Output	Visual Power Output
8	ON/OFF Filaments	Filament Voltage
9	Forward-Reflected	Visual Reflectometer
10	Unused	Unused

In order to control the filament and plate circuits of the visual and aural transmitter, a relay panel consisting of four DPDT latching relays was fabricated. The control relays in the Transmitter Control Unit operated the latching relays which, in turn, controlled the power switching in the visual and aural transmitters.

To control the power output of the visual and aural transmitters, two motorized rheostats were mounted in an enclosed box. Figure 3 shows one

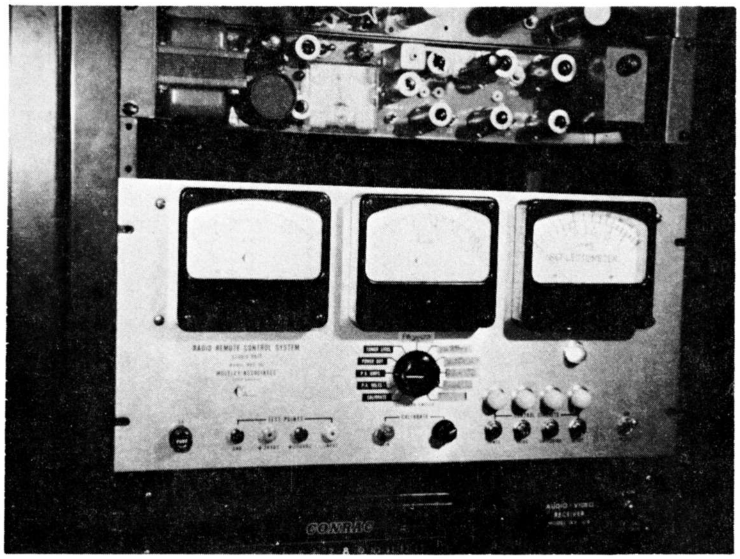


Figure 1.

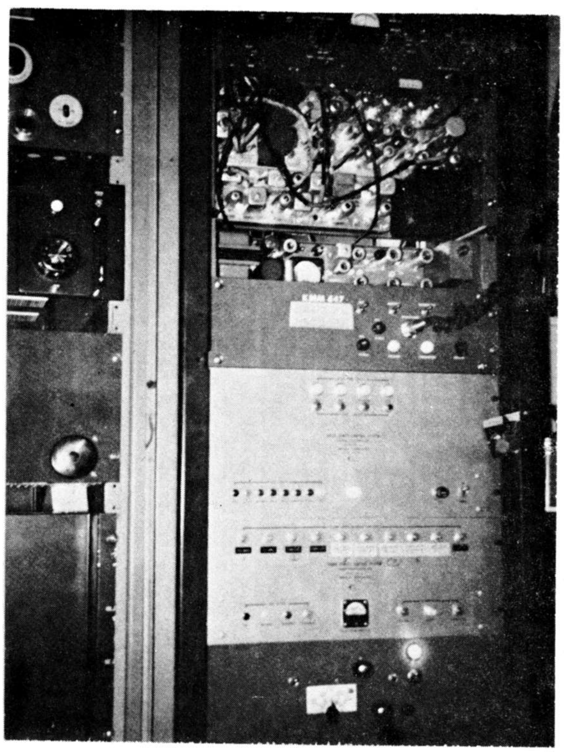


Figure 2.

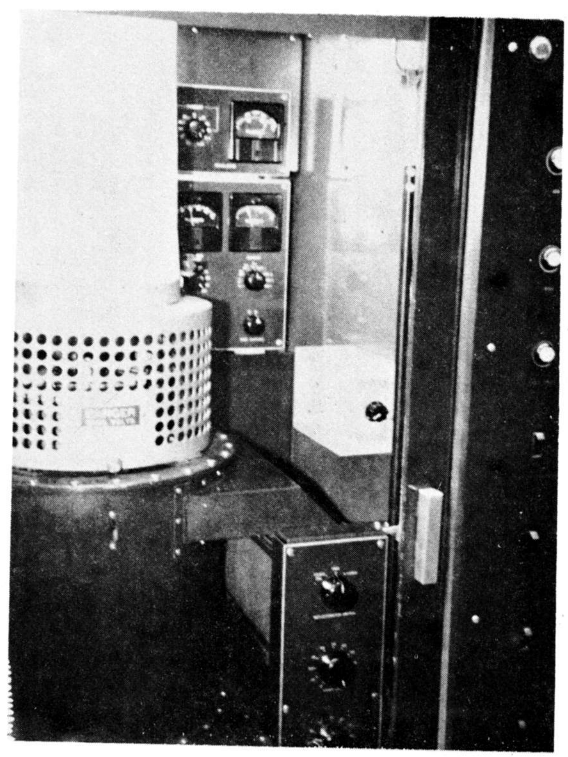


Figure 3.

of these boxes installed in the visual transmitter. The rheostats replaced the power control rheostats supplied by the transmitter manufacturer and a reversible motor was employed to raise and lower power on command. A special clutch arrangement was utilized which would permit the override of any control command.

Due to the circuitry associated with the final amplifiers, only a negative sampling voltage for metering the P.A. current was obtainable. Since the Model RRC-10 is designed to operate with positive metering voltages, a diode modulator was constructed to convert the negative voltages into positive polarity.

Power Amplifier plate voltage was sampled by employing a resistor dividing network from the high voltage bus. The network was designed to minimize the high voltage hazard should any one resistor open circuit.

Calibration

The calibration system associated with the Model RRC-10 allows for the compensation of system drifts regardless of origin. In operation, a 1.4 volt mercury cell is fed into the "home" position (RESET) of the stepper switch. This causes the metering oscillator to assume a frequency of approximately 21.7 kc. When the RAISE control is activated, a relay in the

Transmitter Metering Unit removes this voltage from the input to the metering oscillator and replaces it with a resistor to ground. The frequency of the oscillator then moves to about 21.5 kc. The studio controller then has the opportunity of checking both gain and centering of the metering system. Once the correct gain and zero response of the system has been achieved, pressing the RAISE control in the RESET position calibrates the system.

When, the system is in calibration, it is necessary to place the selector switch on the desired control position and to adjust the individual calibration controls on the Transmitter Metering Unit until the remote meter indication corresponds to the value being measured.

General

Fail-safe operation is provided for in a manner similar to that used in the FM broadcast service. The AGC, or squelch relay, in the 6.2 mc sub-carrier receiver is used to control the plate power to the transmitter so that if either the TV STL carrier or the subcarrier is lost, the transmitters are removed from the air.

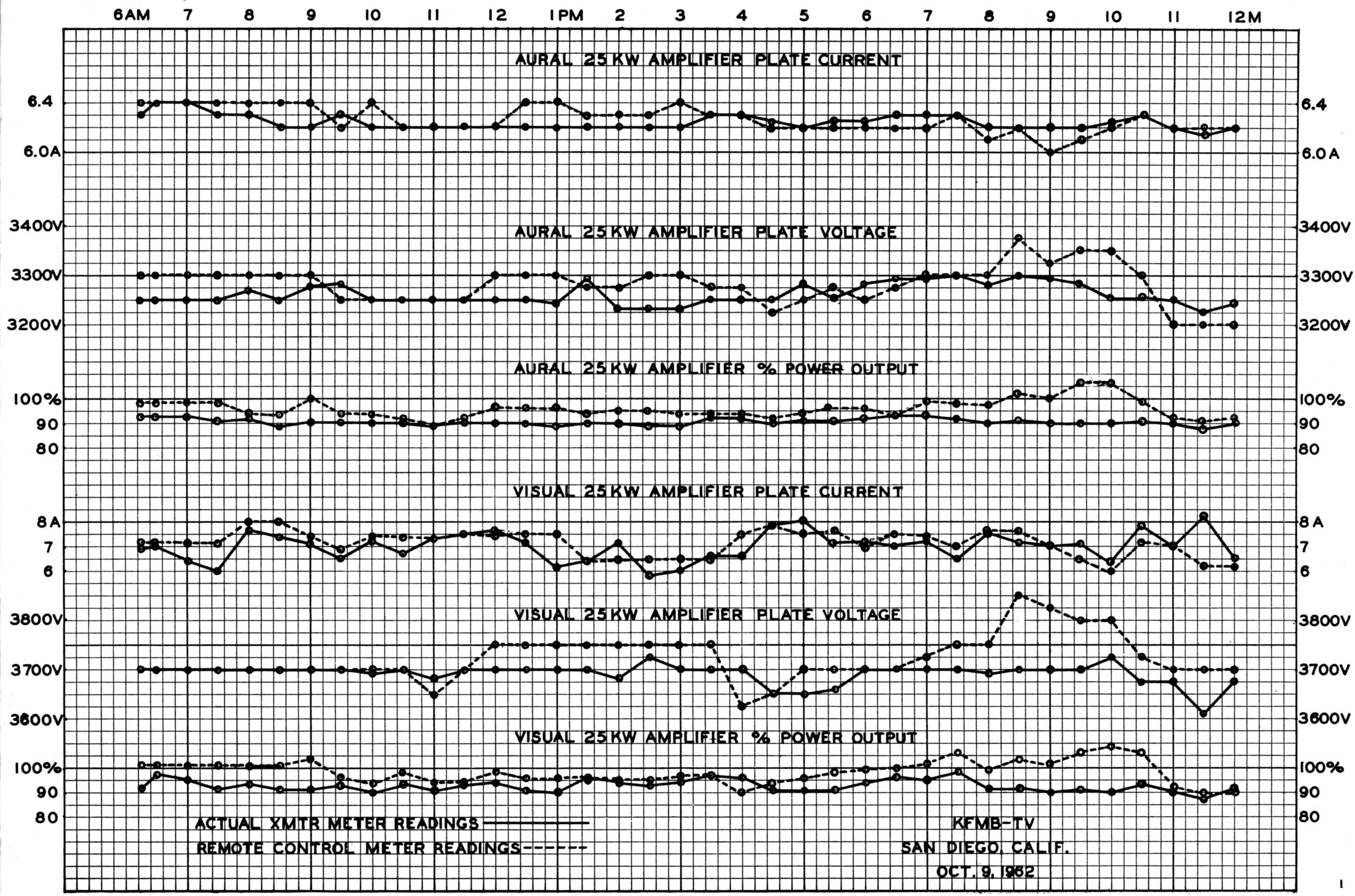
Although not employed in the KFMB-TV experiment, the Model RRC-10 Radio Remote Control System lends itself quite readily to automatic logging of transmitter functions. Only the addition of a mechanical "code" wheel is

necessary to generate short impulses of the STEPPER/RESET control oscillator. The readback voltage obtained from the frequency discriminator in the Studio Control Unit can be applied to a strip chart recorder to obtain a permanent record. The drive motor can be used to put a time correlation mark on the chart.

Alarm functions can be added to the metering system by using low frequency (not conflicting with metering signals) resonant reed oscillators and detectors. For example, a low power indication could trigger a 125 cps oscillator which could be relayed on the 21.5 kc metering subcarrier to the studio. A reed detector would sense the presence of the 125 cps signal and operate an appropriate alarm device.

REMOTE AND TRANSMITTER METERING COMPARISON

In the following graphs, the remote control readings are compared to the readings taken at the transmitter as recorded in the transmitter log. The graphs shown herein are a representative sampling of the data obtained during the course of the entire experiment. It should be noted that remote and transmitter meter readings were not always taken simultaneously and discrepancies between the two metering systems may have resulted.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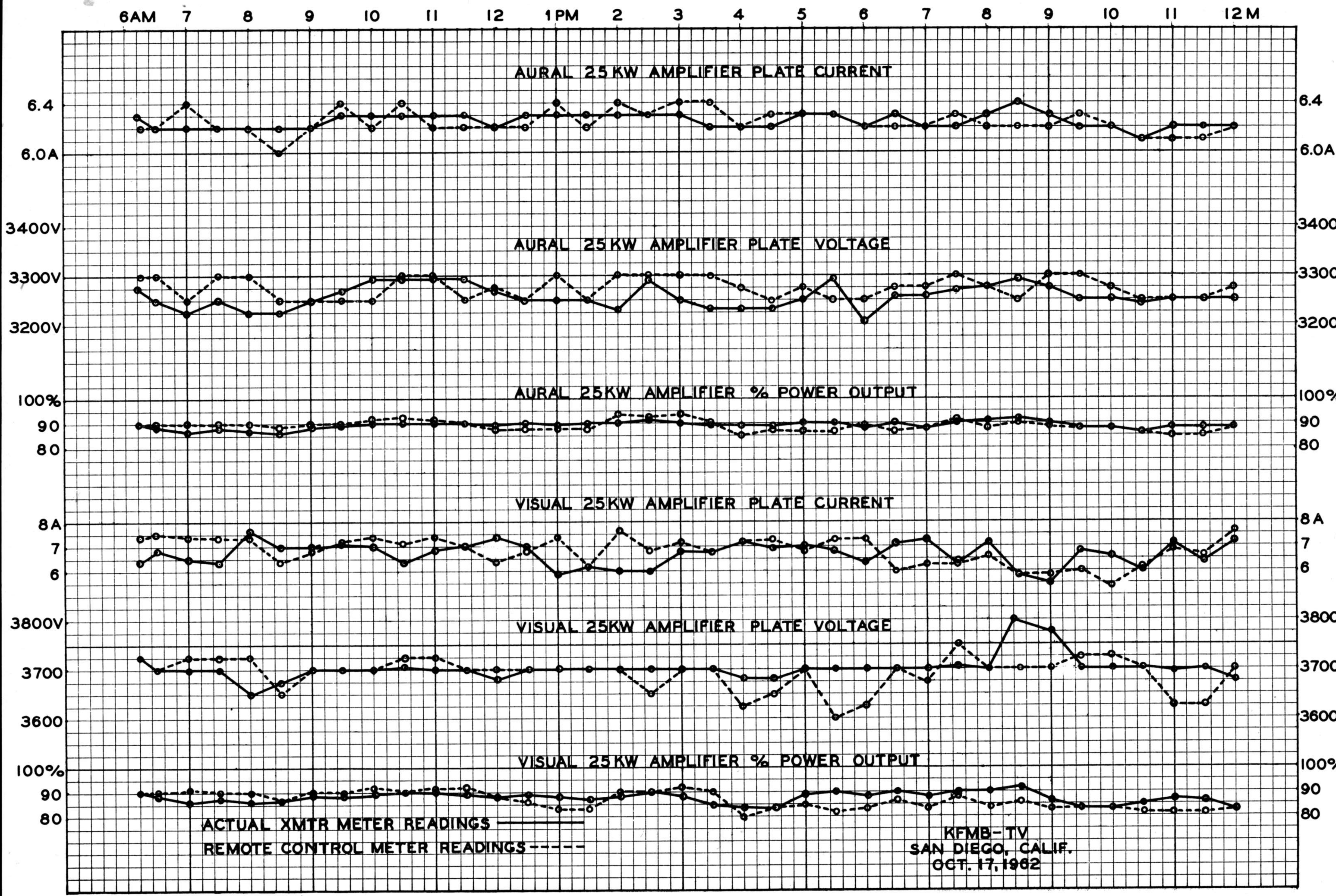
6.4
6.0A
AURAL 25 KW AMPLIFIER PLATE VOLTAGE
3400V
3300V
3200V
AURAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
VISUAL 25 KW AMPLIFIER PLATE CURRENT
8A
7
6
VISUAL 25 KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
OCT. 9, 1962



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6.4
6.0A
3400V
AURAL 25KW AMPLIFIER PLATE VOLTAGE
3300V
3200V
100%
AURAL 25KW AMPLIFIER % POWER OUTPUT
90
80
VISUAL 25KW AMPLIFIER PLATE CURRENT
8A
7
6
3800V
VISUAL 25KW AMPLIFIER PLATE VOLTAGE
3700
3600
100%
VISUAL 25KW AMPLIFIER % POWER OUTPUT
90
80
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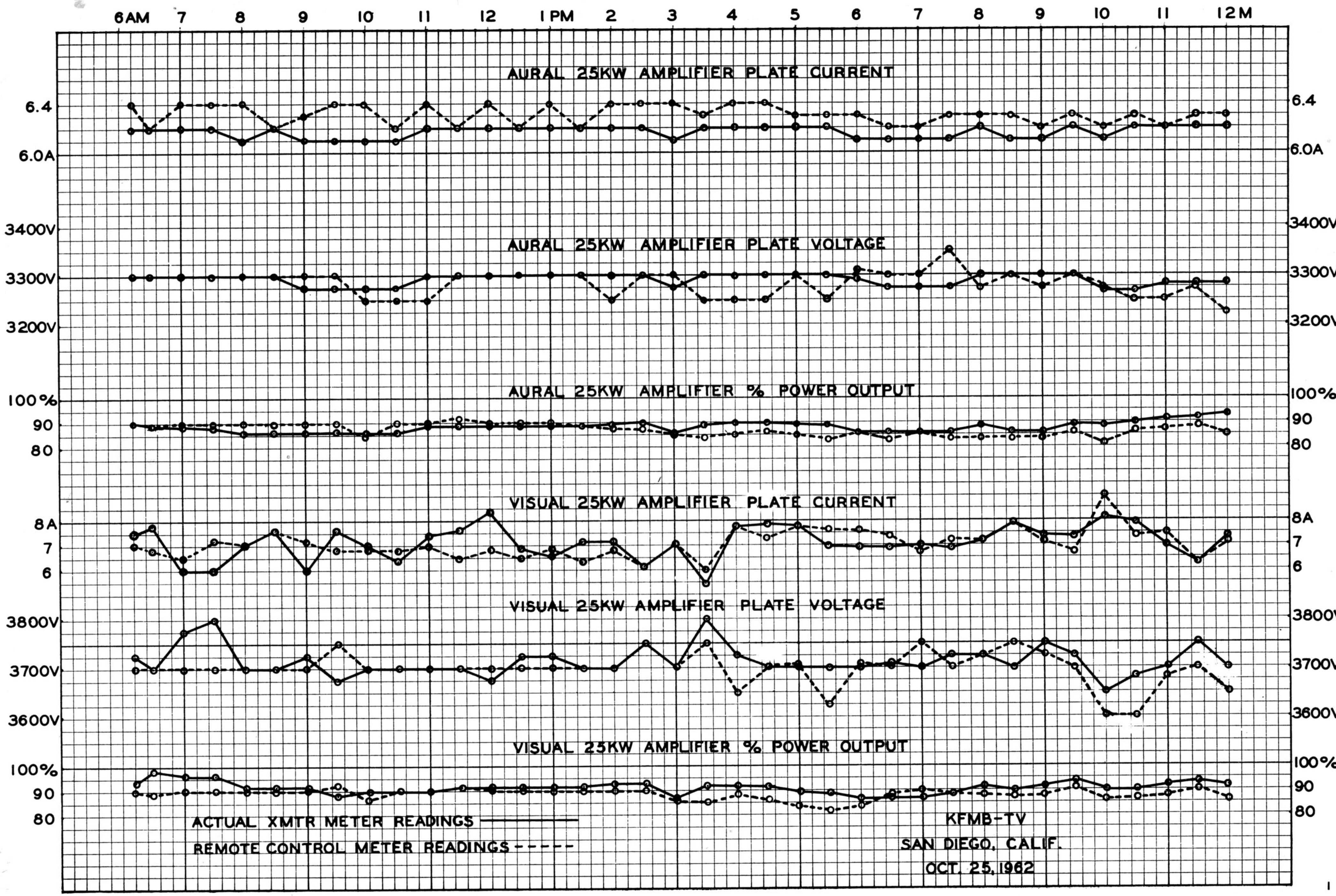
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
OCT. 17, 1962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3400V
3300V
3200V
AURAL 25KW AMPLIFIER % POWER OUTPUT
100%
90
80
VISUAL 25KW AMPLIFIER PLATE CURRENT
8A
7
6
VISUAL 25KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25KW AMPLIFIER % POWER OUTPUT
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REMOTE CONTROL METER READINGS
KFMB-TV
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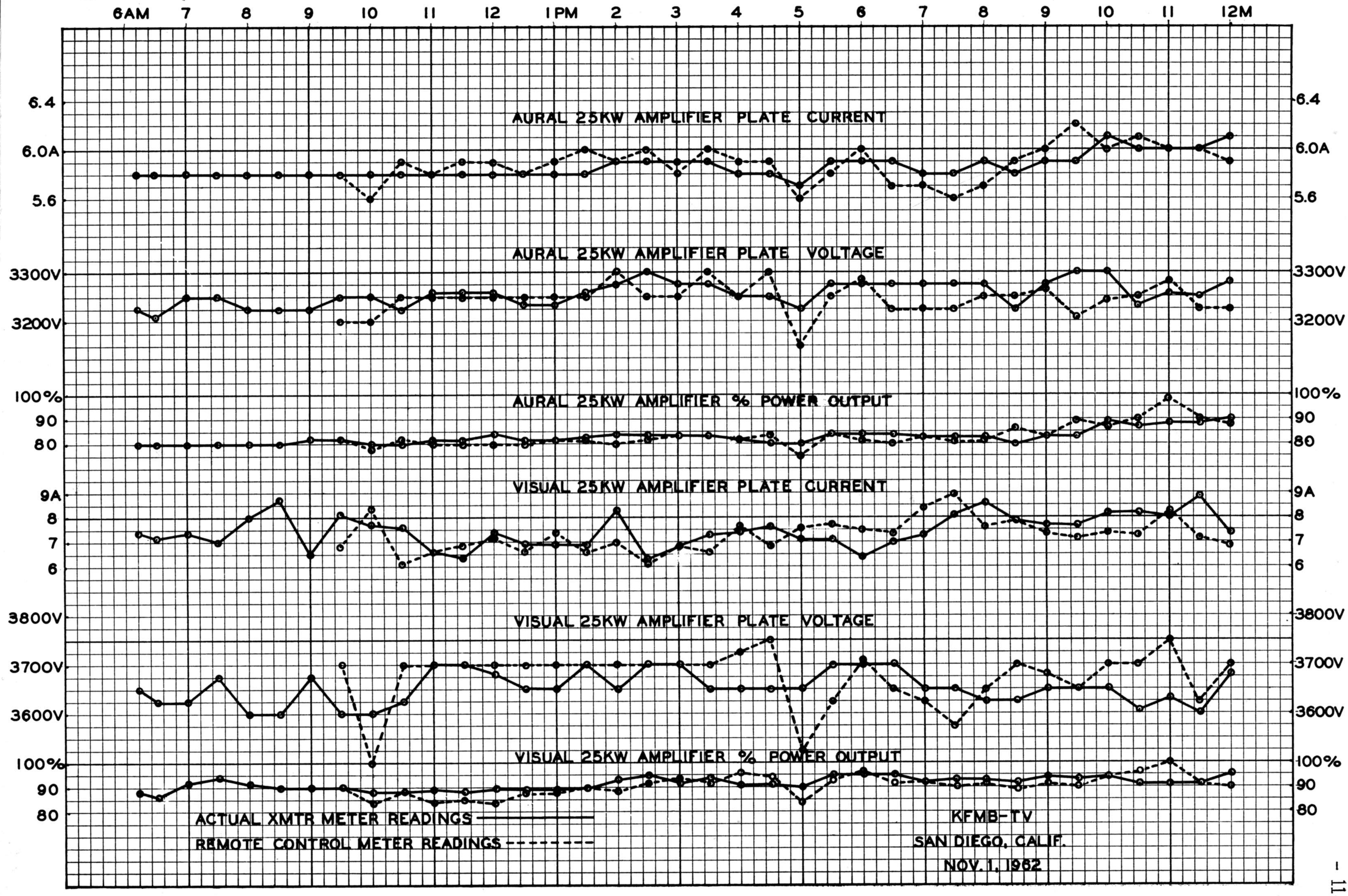
OCT. 25, 1962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3300V
3200V
AURAL 25KW AMPLIFIER % POWER OUTPUT
100%
90
80
VISUAL 25KW AMPLIFIER PLATE CURRENT
9A
8
7
6
VISUAL 25KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25KW AMPLIFIER % POWER OUTPUT
100%
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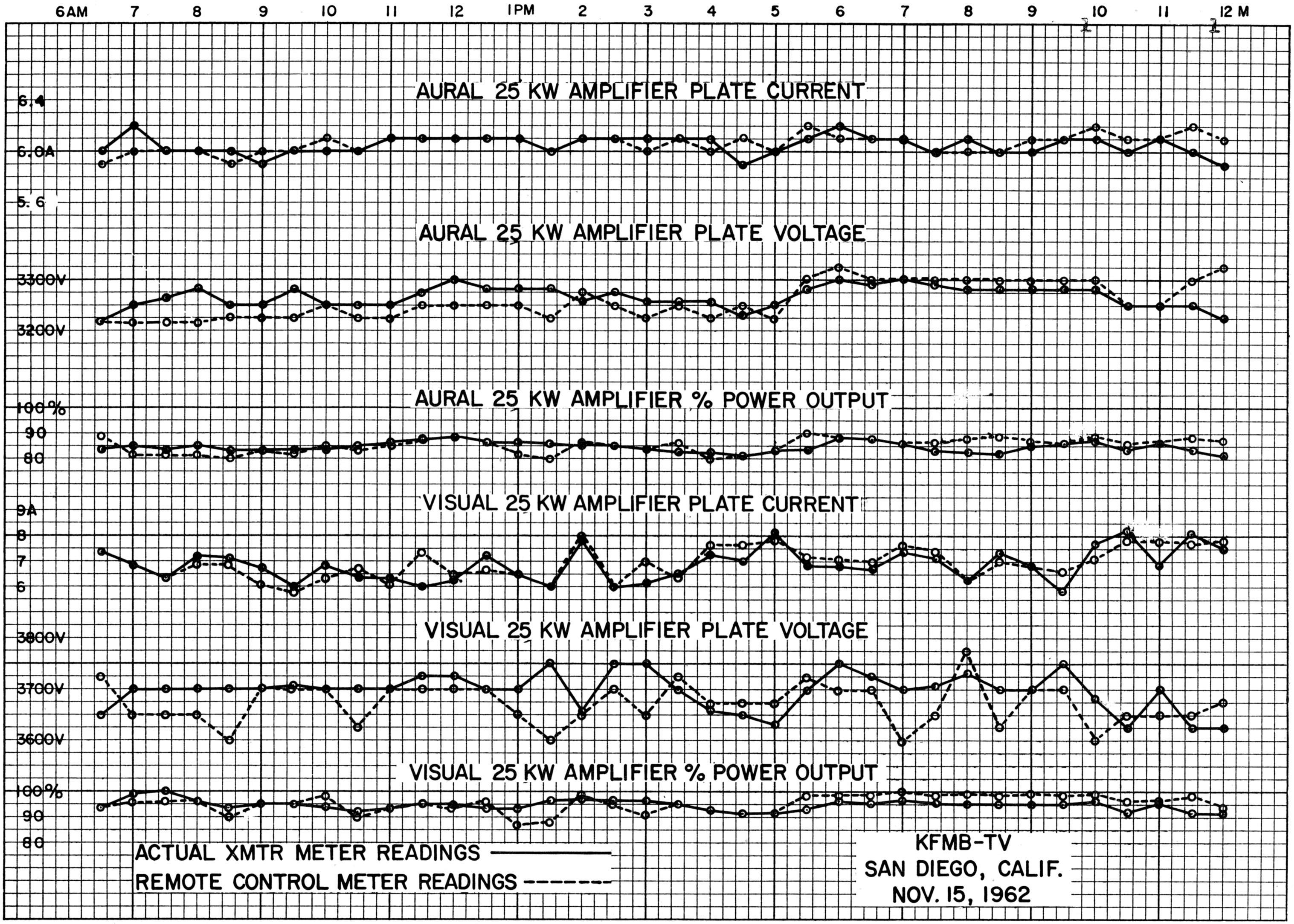
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
NOV. 1, 1962



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6.0A
5.6
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3300V
3200V
AURAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
VISUAL 25 KW AMPLIFIER PLATE CURRENT
9A
8
7
6
VISUAL 25 KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25 KW AMPLIFIER % POWER OUTPUT
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REMOTE CONTROL METER READINGS
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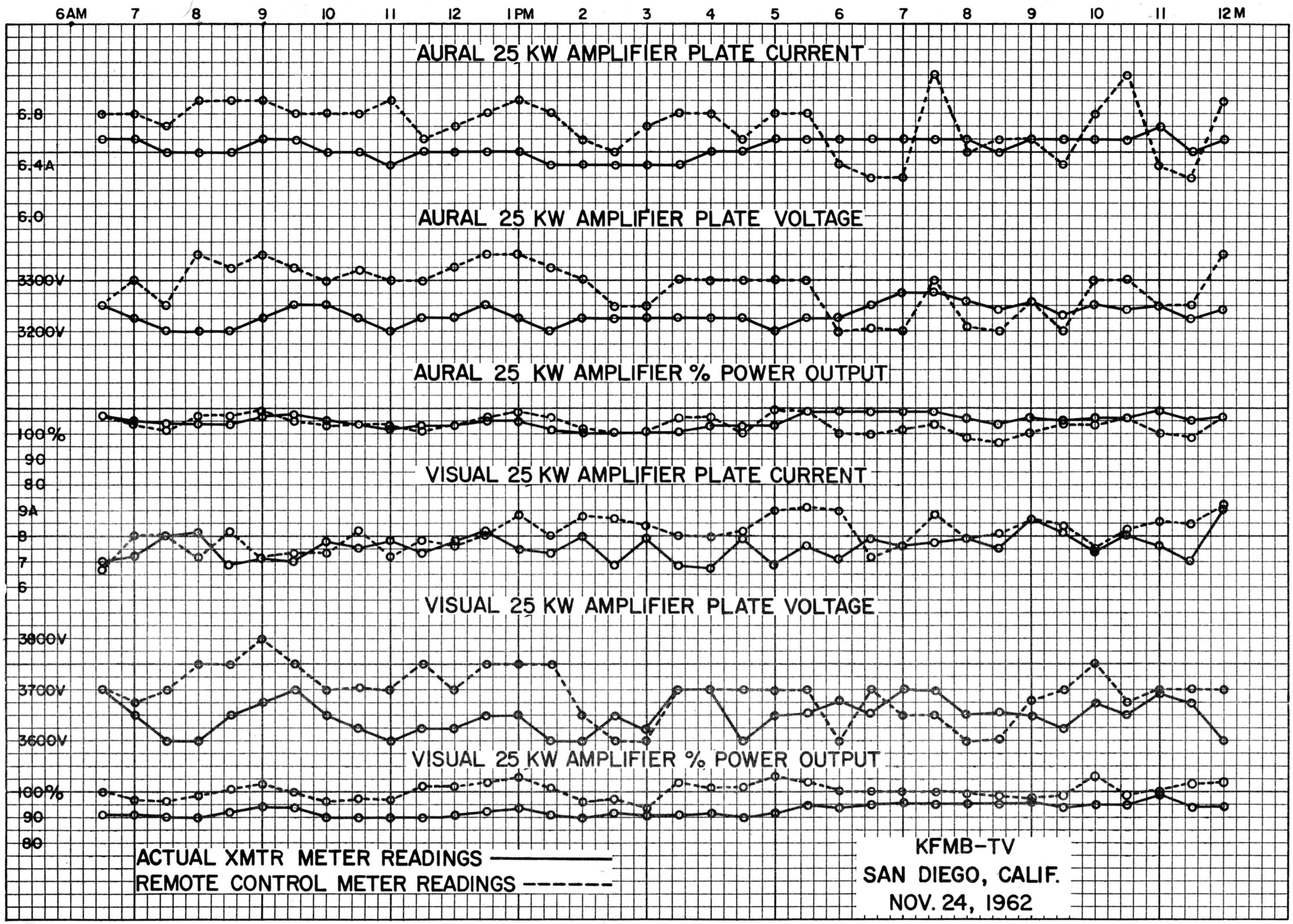
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6.4A
6.0
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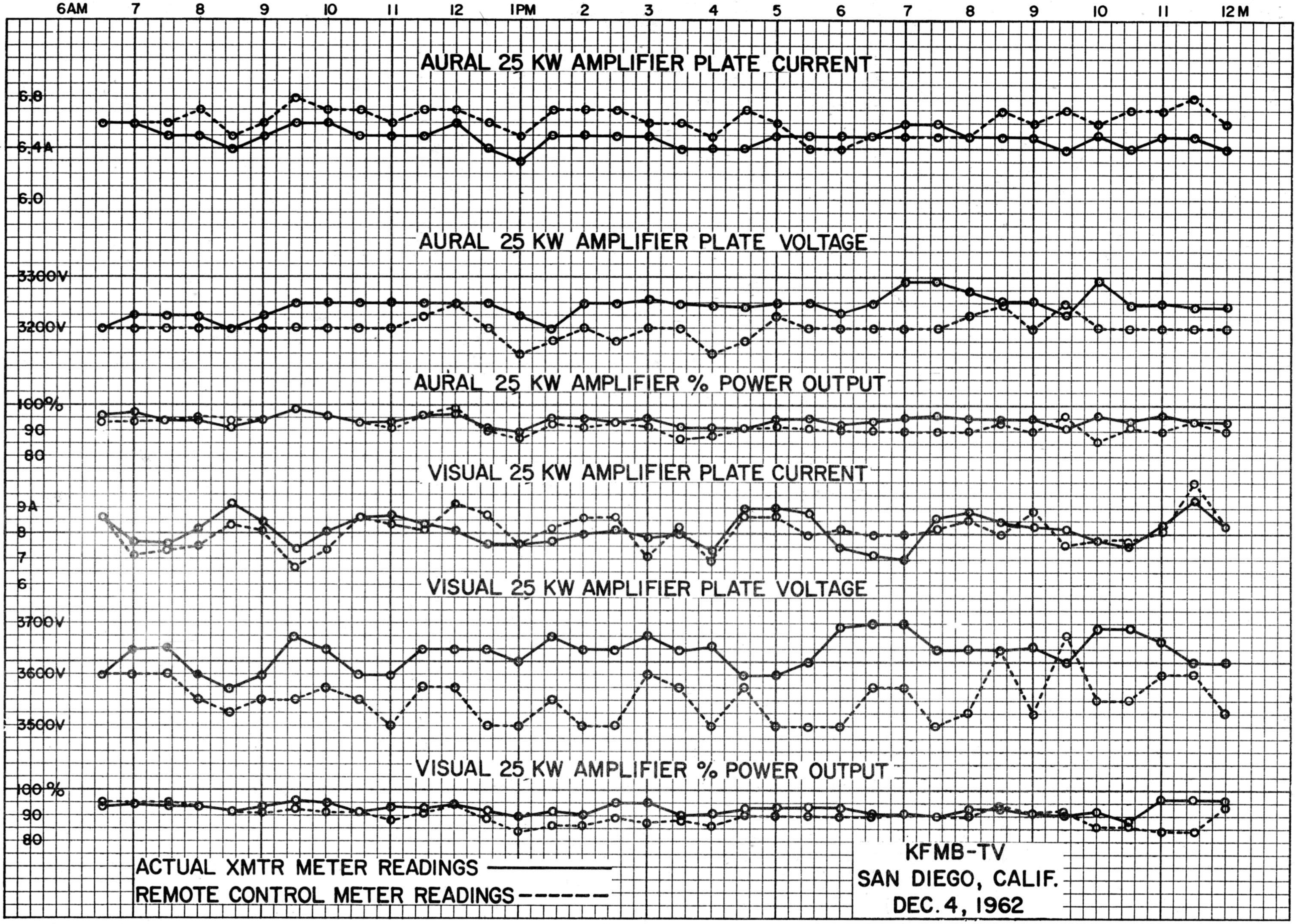
3300V
3200V
AURAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
VISUAL 25 KW AMPLIFIER PLATE CURRENT
9A
8
7
6
VISUAL 25 KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
NOV. 24, 1962



6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12M
AURAL 25 KW AMPLIFIER PLATE CURRENT
6.8
6.4A
6.0
AURAL 25 KW AMPLIFIER PLATE VOLTAGE
3300V
3200V
AURAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
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VISUAL 25 KW AMPLIFIER PLATE CURRENT
9A
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6
VISUAL 25 KW AMPLIFIER PLATE VOLTAGE
3700V
3600V
3500V
VISUAL 25 KW AMPLIFIER % POWER OUTPUT
100%
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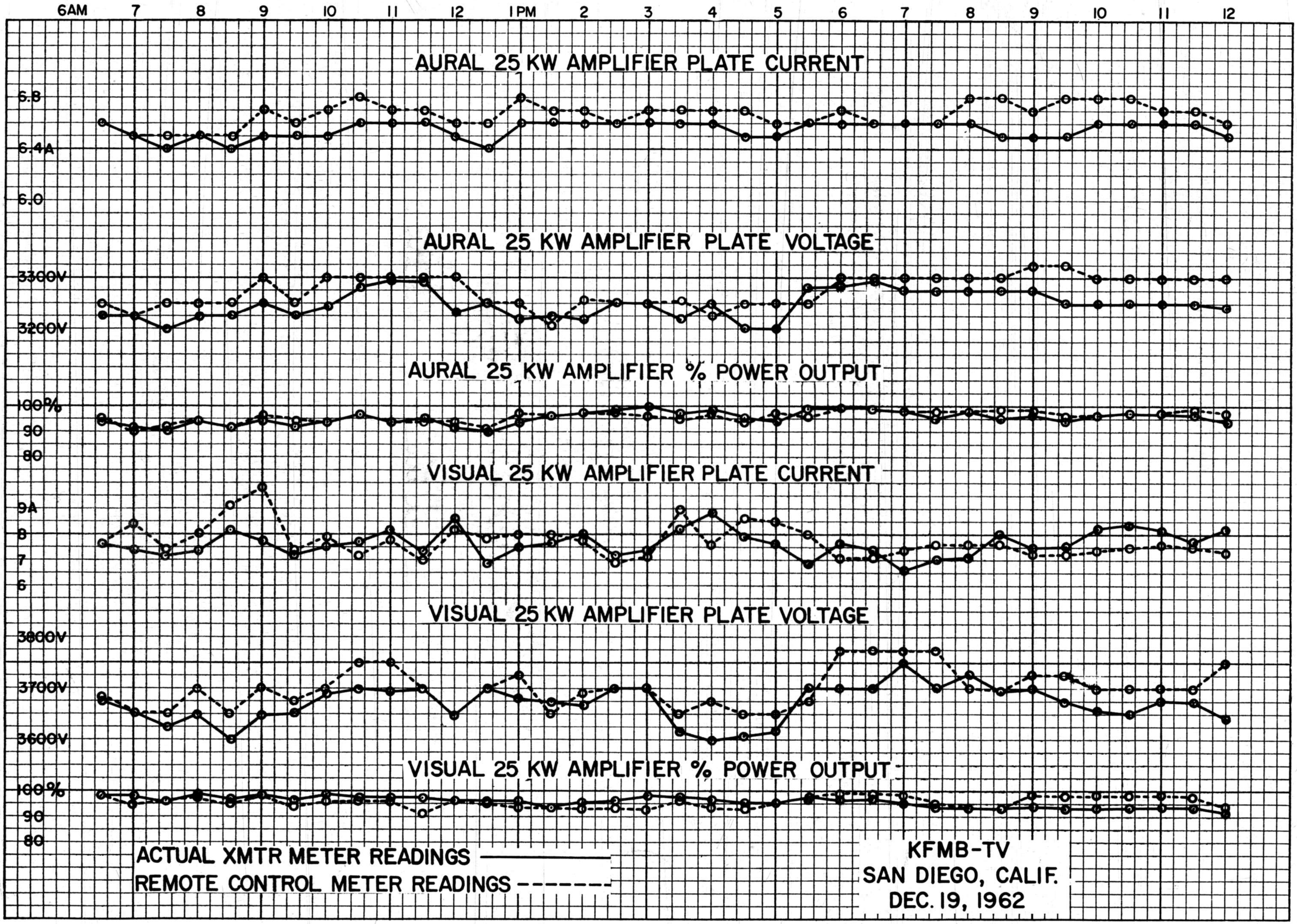
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
DEC. 4, 1962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6.4A
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3300V
3200V
AURAL 25 KW AMPLIFIER % POWER OUTPUT
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VISUAL 25 KW AMPLIFIER PLATE CURRENT
9A
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VISUAL 25 KW AMPLIFIER PLATE VOLTAGE
3800V
3700V
3600V
VISUAL 25 KW AMPLIFIER % POWER OUTPUT
100%
90
80
ACTUAL XMTR METER READINGS
REMOTE CONTROL METER READINGS
KFMB-TV
SAN DIEGO, CALIF.
DEC. 19, 1962

SUMMARY OF RESULTS OF KFMB-TV REMOTE CONTROL EXPERIMENT

As stated previously, this portion of the experiment was designed to test the feasibility of remotely controlling a large VHF-TV transmitter using an existing multiplex remote control system with slight modifications.

It will be noted from Table 1 that the functions performed could be considered adequate to exercise operating control over the transmitting installation. The control of the KFMB-TV transmitter, from the remote location, resulted in no degradation of either equipment performance or technical standards and in this respect can be considered completely successful.

The remote metering system was equally successful and any deviations between the remote and regular metering were due to calibration or meter reading timing discrepancies. There were no remote metering malfunctions during the test and no degradation of the aural program occurred due to multiplexing the metering information on the sound carrier.

No attempt was made to remotely read frequency deviation or percentage of modulation since it was felt that the reading of these instruments at the remote location could be easily accomplished and posed no great difficulties.

REMOTE CONTROL EXPERIMENT

WGEM-TV

Quincy, Illinois

INTRODUCTION

Station WGEM-TV is licensed to the Quincy Broadcasting Company and operates on Channel 10, assigned to Quincy, Illinois. The studios are located at 513 Hampshire Street, Quincy, Illinois, and the transmitter on Columbus Highway, four miles northeast of the city. (Coordinates N 39-57-03, W 91,19,54). The station is authorized to operate with an Effective Radiated Power of 316 kilowatts at an antenna height of 780 feet above average terrain.

The purpose of the WGEM-TV experiment was to: 1) establish the feasibility and practicality of utilizing existing wireline remote control equipment with a transmitter not specifically designed for remote control operation; and 2) develop a practical and reliable method of observing the pertinent characteristics of the transmitted visual signal and the percentage of modulation of the transmitted aural signal at the remote control point. The remote control system was supplied by the Gates Radio Company of Quincy, Illinois, manufacturers of broadcast and wireline remote control equipment. The monitoring equipment installed at the remote control point was supplied by Conrac.

Since wirelines were utilized, no experimental authorization was required from the Commission, but informal notification was made by letter on June 18, 1963. The tests were carried out from June through October of

1963 and remote meter readings were taken over most of this period.

The holder of a First-Class Radiotelephone license was present at the transmitter during all periods of operation as required by Section 73.661 of the Commission's Rules. A regular transmitter log was maintained and the transmitter was under the immediate supervision of a First-Class license holder at all times. A telephone talkback circuit was provided between the transmitter and studio (remote control point) so that a continuous check could be made on the operation of the system.

DESCRIPTION OF TRANSMITTER

The transmitter is a Standard Electronics Model TH-654, which has a rated power output of 50 kw visual, and 25 kw aural. The visual and aural transmitters each consist of two transmitters feeding a power combining network. The two visual transmitters are rated at 12.5 kw.

As operated at WGEM-TV, the power output from the combined visual transmitters is 33.2 kw, and the output of the combined aural transmitters is 16.6 kw. The output is fed to an RCA TF-12AH antenna, which produces an Effective Radiated Power of 316 kw visual and 158 kw aural.

Since no provision for remote control is incorporated in the transmitter,

certain modifications were made to the equipment. These modifications, described later in this report, in no way effected the over-all operation or performance of the transmitter.

REMOTE CONTROL SYSTEM

Introduction

The basic remote control system employed in this test was a Gates Model RDC-200A which is a DC operating system of advanced design. The system utilized two metallic pairs between the studio and transmitter - a cable distance of approximately 9 miles. Wire lengths of as much as 60 miles can be accommodated, however, with this system. The highest current drain of any switching function is 6 ma. and a total of 39 metering positions are provided for. Transmitter and studio units have self-contained power supplies and are independent operating units. The remote control unit also meets all the Commission's fail-safe requirements.

General

The Gates RDC-200A system achieves control circuit selection by applying, to the control line, voltages of certain magnitude and polarity. Pulse-reset is accomplished over the metering line. When either the pulse or reset circuit is activated, transfer relays at the studio and transmitter ends

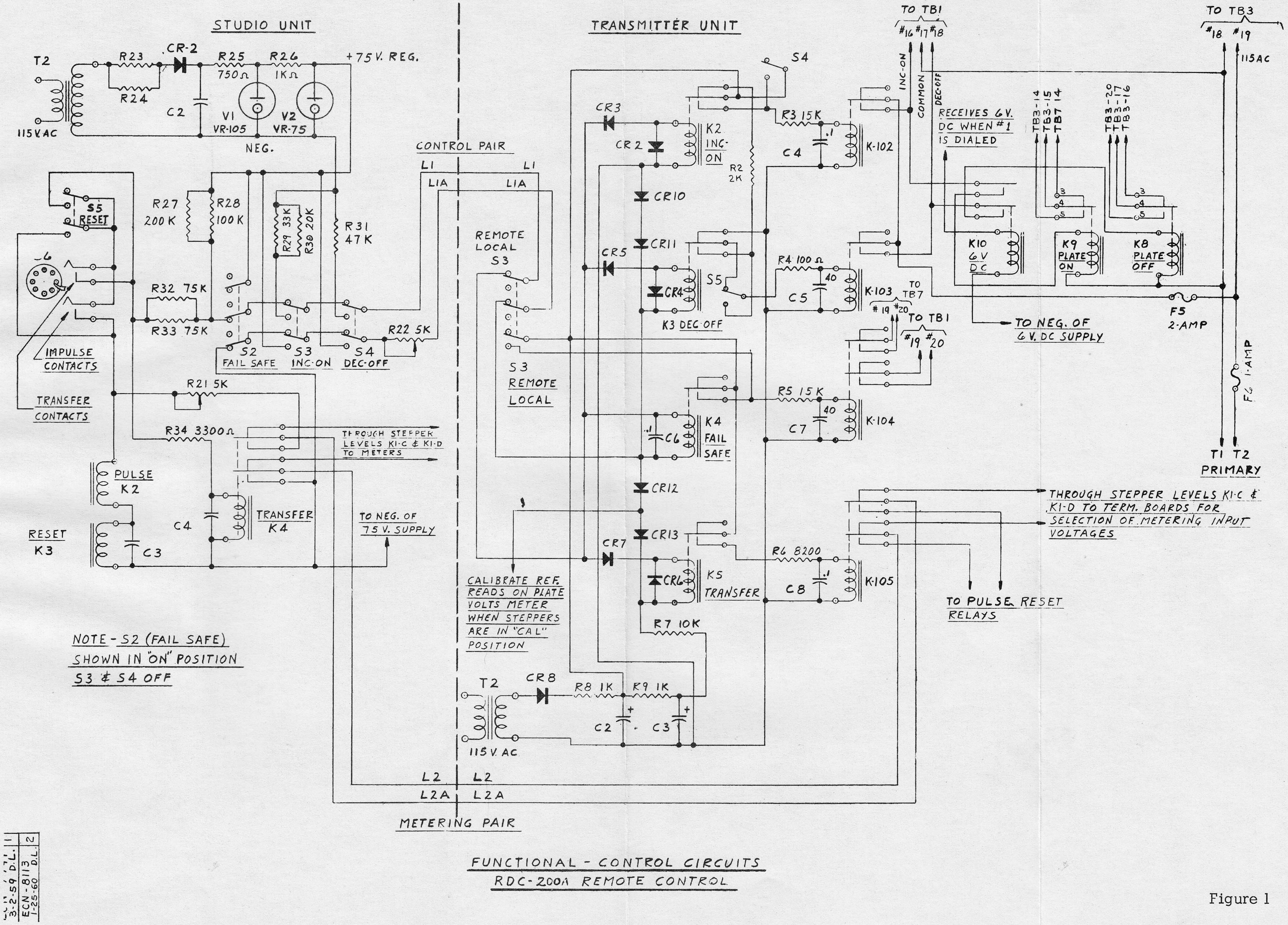
of the line lift the metering circuits and substitute the pulse-reset circuits. At the end of the pulse-reset period, the meter line returns to normal status.

The transmitter unit employs four main channels for switching. These are increase-on, decrease-off, fail-safe and transfer. Each channel is made up of two relays; one is a sensitive type relay operated from the control line and the other is a slave relay which performs the actual switching operations.

Transmitter Unit

Reference is made to Figure 1 which contains the principle control elements associated with the studio and transmitter units. Pulse-reset, metering and stepper switch circuitry is not shown in its entirety. The transmitter unit is shown on the right half of the drawing, the studio unit on the left. Interconnecting the two units is a control and metering pair.

CR10, CR11, CR12 and CR13 are 5 volt Zener diodes with closely controlled reverse breakdown voltage giving good voltage regulation. Approximately 8 ma. of operating current is supplied to these diodes from their associated power supply. This operating current establishes the Zener diodes in the "straight line" portion of their characteristic curves, providing a constant 5 volt drop across each diode.



FUNCTIONAL - CONTROL CIRCUITS
RDC-200A REMOTE CONTROL

Figure 1

CR3, CR5 and CR7 are polarizing diodes. CR3 and CR5 are connected so that K2 and K3 will accept only negative voltages and CR7 will pass only a positive voltage to K5. The constant voltage drop provided by the Zener diodes is used to bias the appropriate relays so that they cannot operate until the applied voltage is great enough to overcome the bias voltage. The coil of K2 is biased 10 volts negative, while the coil of K5 is biased 10 volts positive since the "fail-safe" relay is not polarized, and will operate on voltages of either polarity.

When negative 20 volts is received on the control pair, the cathodes of CR3 and CR5 become more negative than their anodes, allowing these diodes to conduct. K2 coil (because of its 10 volts negative bias) received 10 volts, this voltage energizes K2. K3 coil (having no bias) receives the full 20 volts, thus energizing K3.

When K3 closes, R-C delay network R2 and C5 delay the operation of K103 long enough for K2 to energize first. Once energized, the K2 back contacts open to disable the feed to K103; at the same time it operates slave relay K102. K102 actuates the "increase-on" 115 volt a.c. switching circuit. The "fail-safe" relay also operates, keeping its associated slave relay energized.

Negative 10 volts is received on conductor L1 of the control pair.

Due to the 10 volts negative bias on coil K2, the net drop across this coil is zero. K3 coil (with no bias) receives the full 10 volts, thus energizing it which in turn feeds B plus voltage to K103, causing it to close. When K3 drops out, the back contacts short circuit capacitor C5 through the 100 ohm resistor R4 thus releasing K103. K103 actuates the 115 volt a.c. "decrease-off" circuit. The "fail-safe" relay also operates on this voltage and keeps its associated slave energized.

K104 holds the transmitter on the air. Studio unit switches, which apply the various voltages to the line are interlocked. When a switch is operated to perform a certain switching function, the normal "fail-safe" voltage is temporarily removed and replaced by one of the other three voltages depending upon the circuit selected. K4 operates on its own positive 10 volts, and on any of the other three voltages. Capacitor C7 prevents this relay from releasing during periods of switching at the studio unit.

K5 is operated with +20 volts on the control line. Because of the 10 volts positive bias, this relay receives 10 volts operating potential and energizes. Upon energizing, its contacts supply voltage to the associated slave relay which in turn transfers the metering line from metering to pulsing circuits.

CR2, CR4 and CR6 are quenching diodes used to short circuit the generated back voltage brought about by the collapsing flux field. Capacitors C4 and C8 are arc suppressors for their respective coils.

S3 is remote-local switch, shown in remote position. When thrown to local, the two upper arms open the control pair, rendering the equipment inoperative from the studio unit. The lower set of contacts apply energizing voltage to the fail-safe slave relay, permitting local operation.

S4 provides the local "increase-on" operation. When operated, this switch applies energizing voltage to the "increase-on" slave relay. S5 provides "decrease-off" control in the same manner. If S4 and S5 are inadvertently activated at the same time, only the "decrease-off" circuit will function.

One 115 volt a.c. input supplies power to the transmitter unit. This input supplies power to the primaries of T2 and T1 and, in addition, one leg of this input provides power to the switching circuits. All inputs are adequately fused.

Relays K8, K9 and K10 were incorporated to provide plate "on-off" control in single transmitter installations. They may, however, be used for filament or other control circuits as the installation may demand.

Studio Unit

Two power supplies are contained in the studio unit. A 6 volt d.c. supply which operates the stepper solenoid and a 75 volt regulated supply. The output of this supply operates the pulse-reset relays in both the studio and transmitter units. It also furnishes the various voltages for control circuit selection. Double regulation is used to provide more constant output during line voltage and load changes.

The fail-safe switch, S2, is shown in the "on" position and the two lower contacts series through S3 and S4 to the control line. The 75 volt output is dropped through a resistive network to provide correct fail-safe voltage.

When dial switch S6 or reset switch S5 is operated, their transfer reduces the series dropping resistance and provides the necessary voltage increase to operate both the fail-safe and transfer relays at the transmitter unit. At this time the transfer contacts also apply the 75 volts to operate the studio unit transfer relay. The upper arm of S2 "locks out" the 75 volt "pulse-reset" feed when S2 is in the "off" position. Thus, S2 fail-safe switch must be "on" in order for the stepper system to operate. S2 is a holding type lever key switch.

"Increase-on" voltage is applied to the line by momentarilly operating

switch S3. When S3 is operated the normal fail-safe voltage is removed from the line and in its place, a voltage from the 75 volt supply is applied. This voltage operates both the fail-safe and "increase-on" relays at the transmitter unit.

"Decrease-off" voltage is applied to the line by momentarily operating switch S4. When S4 is operated the normal fail-safe voltage is removed from the line, and in its place, a voltage from the 75 volt supply is applied. This voltage operates relays K2, K3 and K4 at the transmitter unit.

Pulsing and Reset

When the dial switch is rotated, its transfer contacts close and energize transfer relays in both the studio and transmitter unit. These relays prepare the metering line to deliver the pulsing voltage from the 75 volt studio supply to the transmitter unit's pulsing system. When the dial is released, the dial's contacts pulse as the dial rotates energizing a pulse relay. The normally open contacts of this relay close with each pulse, applying voltage to the stepping switch. Each pulse received causes it to move the switch arm one step.

The operation of the transmitter unit pulsing relay, reset relay and stepping switch is identical to and synchronous with those in the studio unit.

Metering

The stepper switches are used for metering with level C the negative side and level D the positive side. In the studio unit, level C positions return the common of all three meters through a precision resistor and a meter fuse. The transmitter unit stepper selects the desired meters. The meters have 100 micro-amps movements and, require 5 volts at the studio unit to provide full-scale deflection.

Control

In the WGEM-TV installation, the following functions were remotely controlled:

On/raise	Off/lower
Visual filament on	Visual filament off
Aural filament on	Aural filament off
Visual plate on	Visual plate off
Aural plate on	Aural plate off
Visual power raise	Visual power lower
Aural power raise	Aural power lower
Video raise	Video lower
Sync raise	Sync lower

Although these were the only functions performed, the system is capable of handling additional controls. On/off functions are accomplished by energizing appropriate relays. Visual and aural power raise/lower is achieved by motorizing a 50 watt potentiometer controlling the outputs of the various

units. The synchronizing level and the video gain level in the stabilizing amplifier was also motorized for control of the sync and video gain.

Remote Metering

Metering was accomplished by the use of a conventional resistive voltage sampling network or the rectification of either RF or AC to direct current using a potential acceptable to the remote control and interconnecting metallic circuitry. Figure 2 depicts the metering circuit for remotely monitoring the three-phase 240 volt AC primary line. Figure 3 depicts the metering circuit associated with remotely monitoring the aural and visual frequency deviation, and Figure 4 the remote metering circuit pertaining to the visual and aural power output circuit.

The following readings were telemetered to the remote control point in the sequence tabulated below:

Dial Position	Metered Parameter
1	Tower Lights
2	Visual Interlock
3	Visual 2 Power
4	Visual 3 Power
5	Aural 2 Power
6	Aural 3 Power
7	Visual Power Balance
8	Aural Power Balance
9	Ø 1 AC Line
10	Ø 2 AC Line
11	Ø 3 AC Line
12	Visual Frequency Deviation
13	Aural Frequency Deviation
14	Aural Plate Voltage 2

(Continued)

METERING CIRCUIT FOR REMOTELY MONITORING THREE PHASE 240 V.A.C. PRIMARY POWER LINE

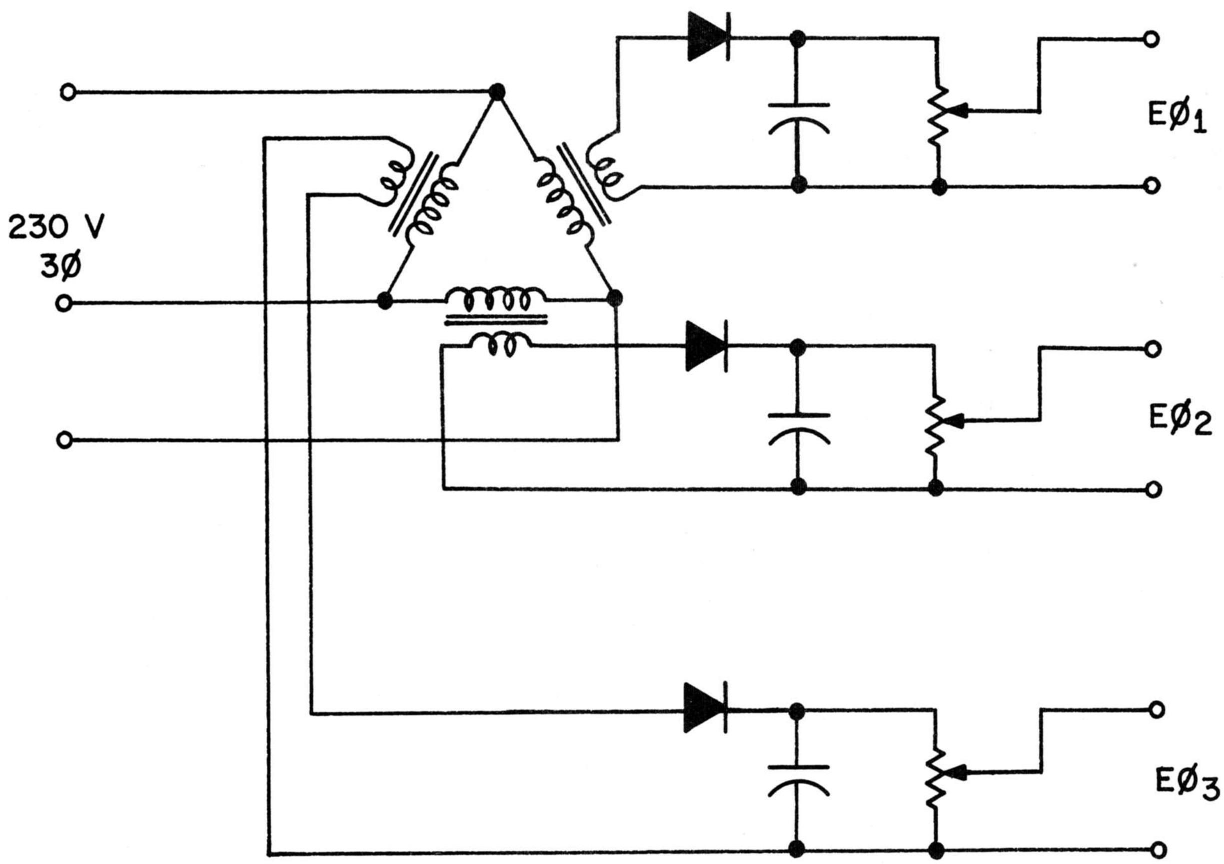


FIG. 2

METERING CIRCUIT FOR REMOTELY MONITORING AURAL AND VISUAL FREQUENCY DEVIATION

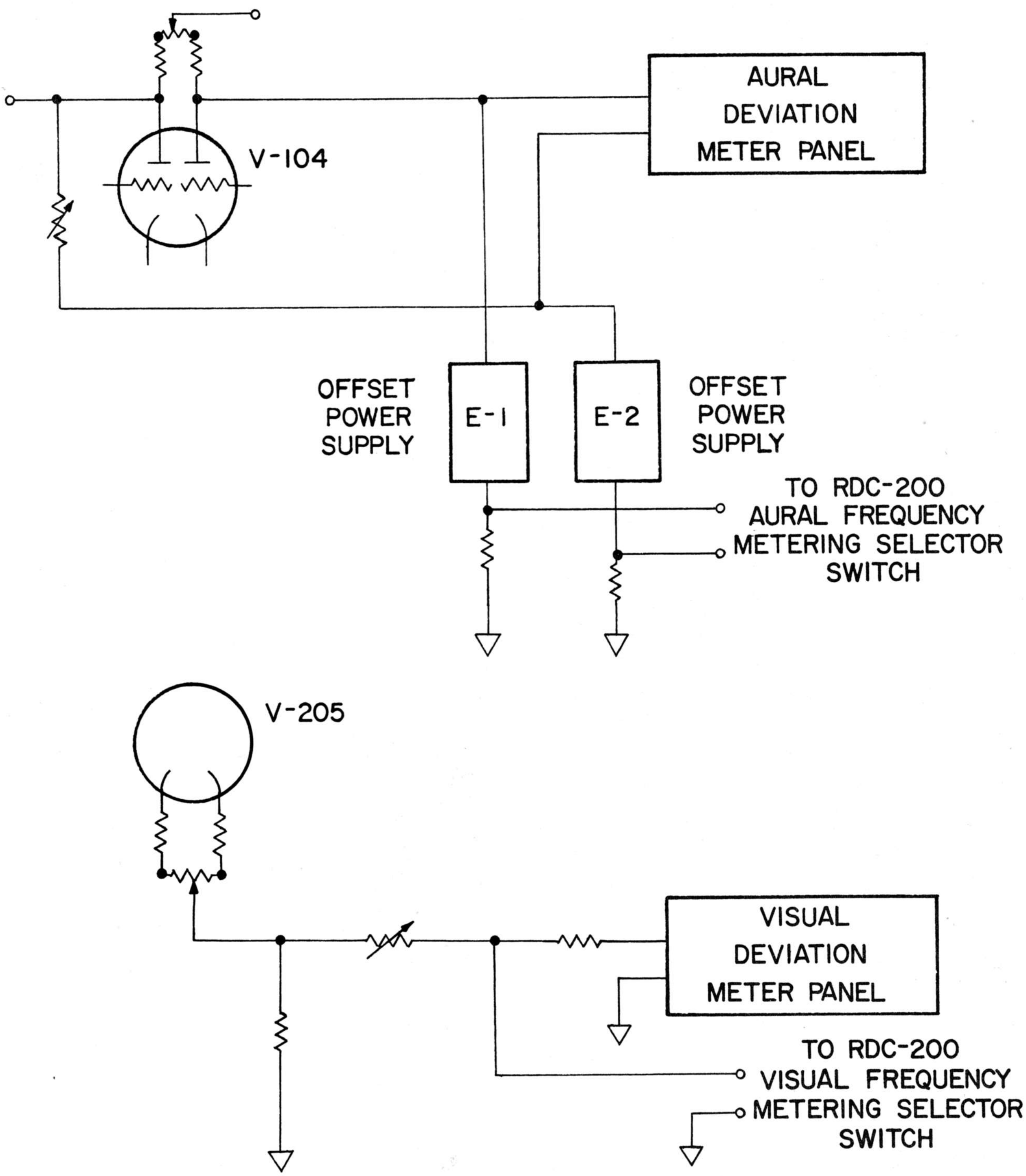


FIG. 3

METERING CIRCUIT FOR REMOTELY MONITORING AURAL AND VISUAL POWER OUTPUT

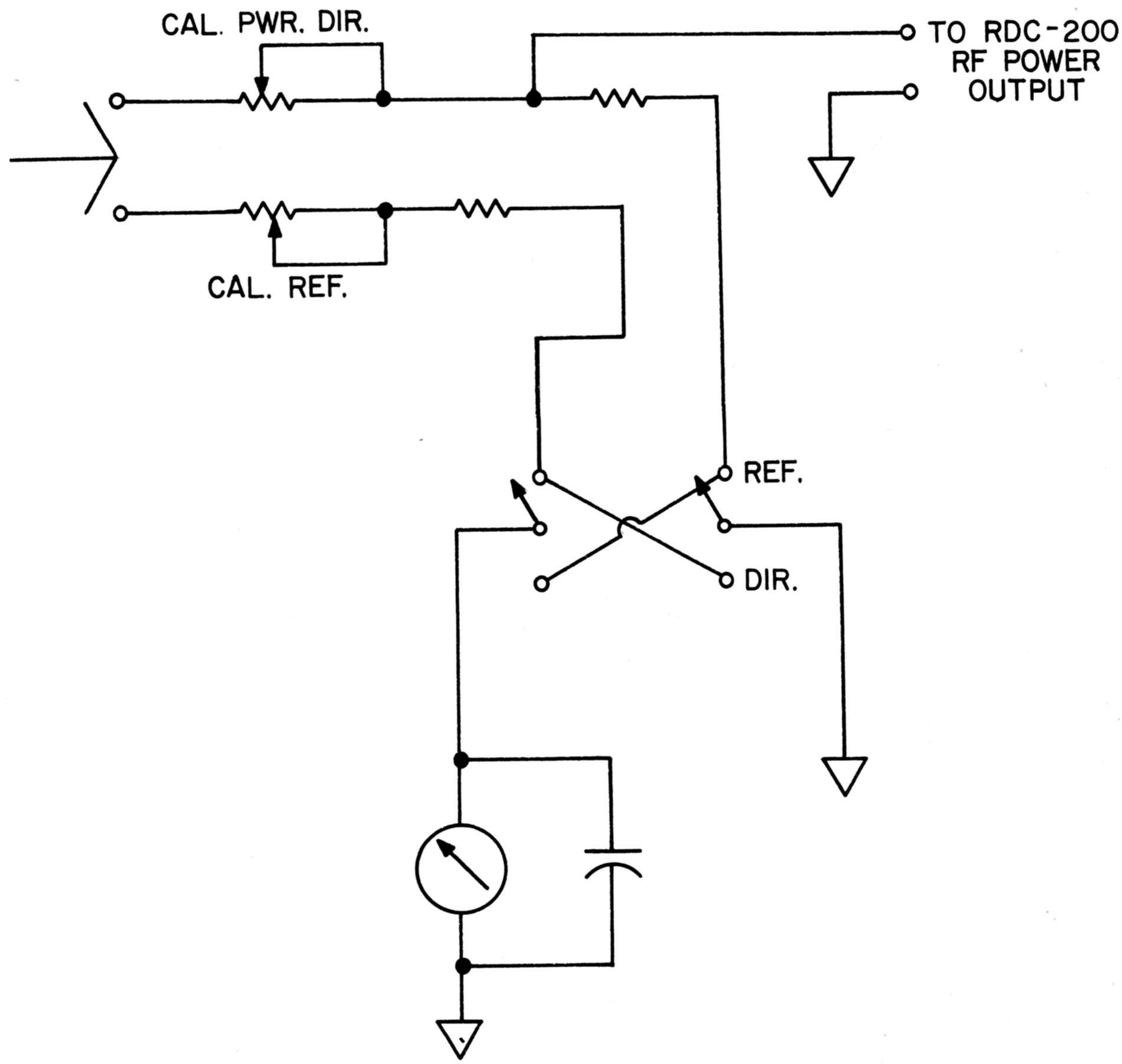


FIG. 4

Dial Position	Metered Parameter
15	Aural Plate Voltage 3
16	Aural Interlock
17	Aural Plate Current 2
18	Aural Plate Current 3
19	Deicers
20	
21	
22	Visual Plate Voltage 2
23	Visual Plate Voltage 3
24	Visual Plate Current 2
25	Visual Plate Current 3

NOTE: Visual 2 and Aural 2, Visual 3 and Aural 3 refers to the dual amplifiers associated with Standard Electronics Transmitter.

STUDIO MONITORING

The control point was equipped with apparatus suitable for observing the pertinent characteristics of the transmitted visual signal and the percentage of modulation of the transmitted aural signal. Monitoring of both the visual and aural portion of the transmitted signal was accomplished from the remote control location by using a sensitive TV receiver and a crystal controlled tuner adapted to operate visual and aural monitors. A crystal controlled tuner was required to maintain proper bandpass and phase response in the US/FCC Vestigial Side-band transmission standards for receiver and transmitter.

A Conrac TV receiver Model AV12E and a crystal controlled HUC-10 Tuner were chosen because of their technical excellence and moderate cost. The receiver video outputs were connected to standard waveform and picture monitors for viewing the transmitted signal. It was, of course, necessary to make several changes to the basic receiver in order to achieve the required monitoring functions associated with proper station operation. Figure 5 is a block diagram of Studio Monitoring facility and Figure 6 is the schematic diagram of the audio/video receiver.

1. <u>Circuit Description of the Conrac Receiving System</u>

The tuner employs a cascode R.F. amplifier, a pentode mixer, and a crystal oscillator and frequency multiplier stage.

<u>I. F. Amplifier</u>

The converter to first I.F. grid coupling network consists of a "staggered couple" with a bifilar-T trap. The mixer plate circuit is tuned to approximately 42 mc. and loosely coupled to a bifilar-T circuit, which is tuned to approximately 45 mc. The associated trap is set to reject 41.25 mc.

The next three interstage networks comprise a flat staggered tuned triple with adjacent channel traps. The first network is a shunt-fed bifilar-T circuit. It is broadly tuned near 43 mc. and the trap is set to produce about 30 db of attenuation at 47.25 mc.

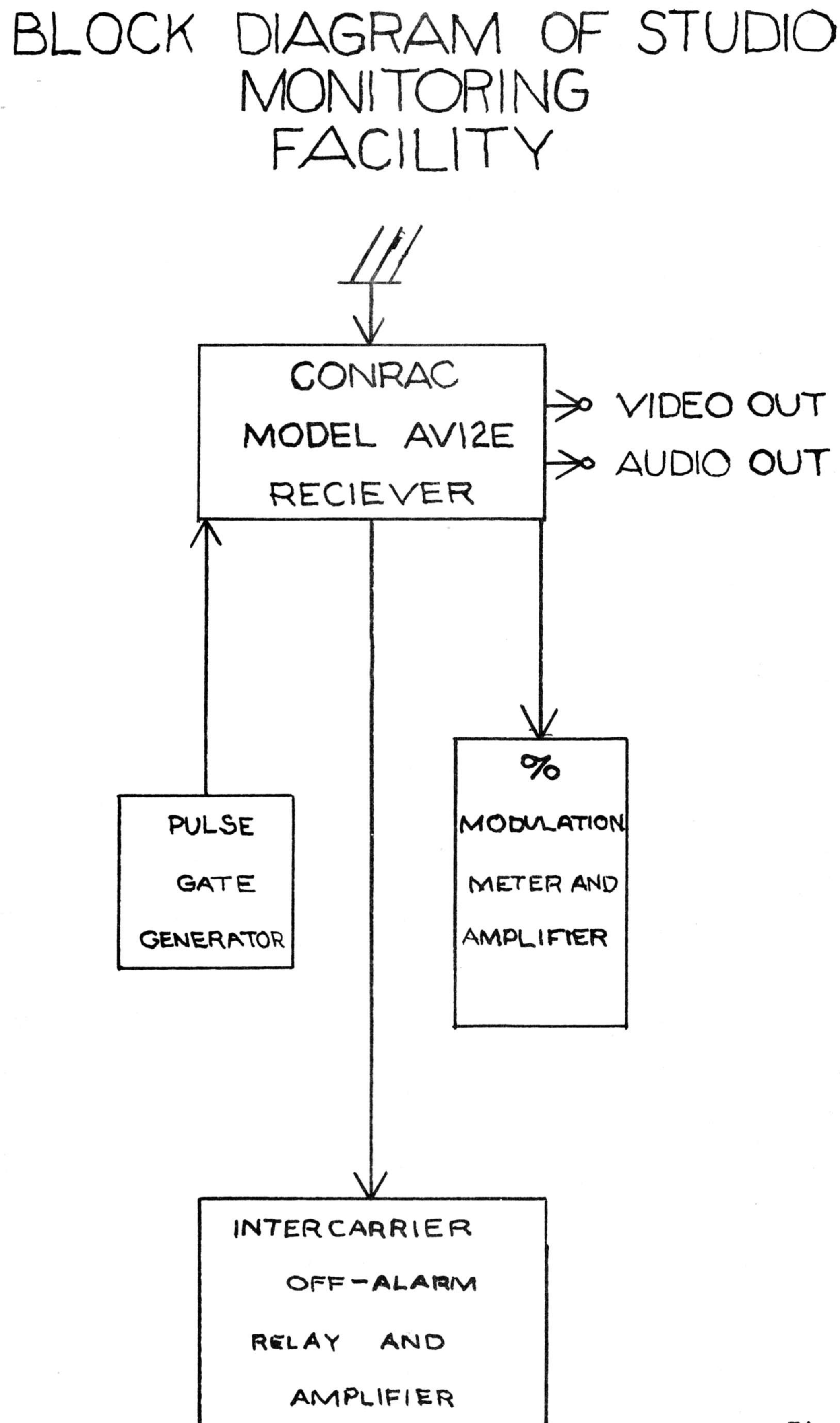

BLOCK DIAGRAM OF STUDIO MONITORING FACILITY
CONRAC MODEL AV12E RECIEVER
VIDEO OUT
AUDIO OUT
PULSE GATE GENERATOR
% MODULATION METER AND AMPLIFIER
INTERCARRIER OFF-ALARM RELAY AND AMPLIFIER

Figure 5.

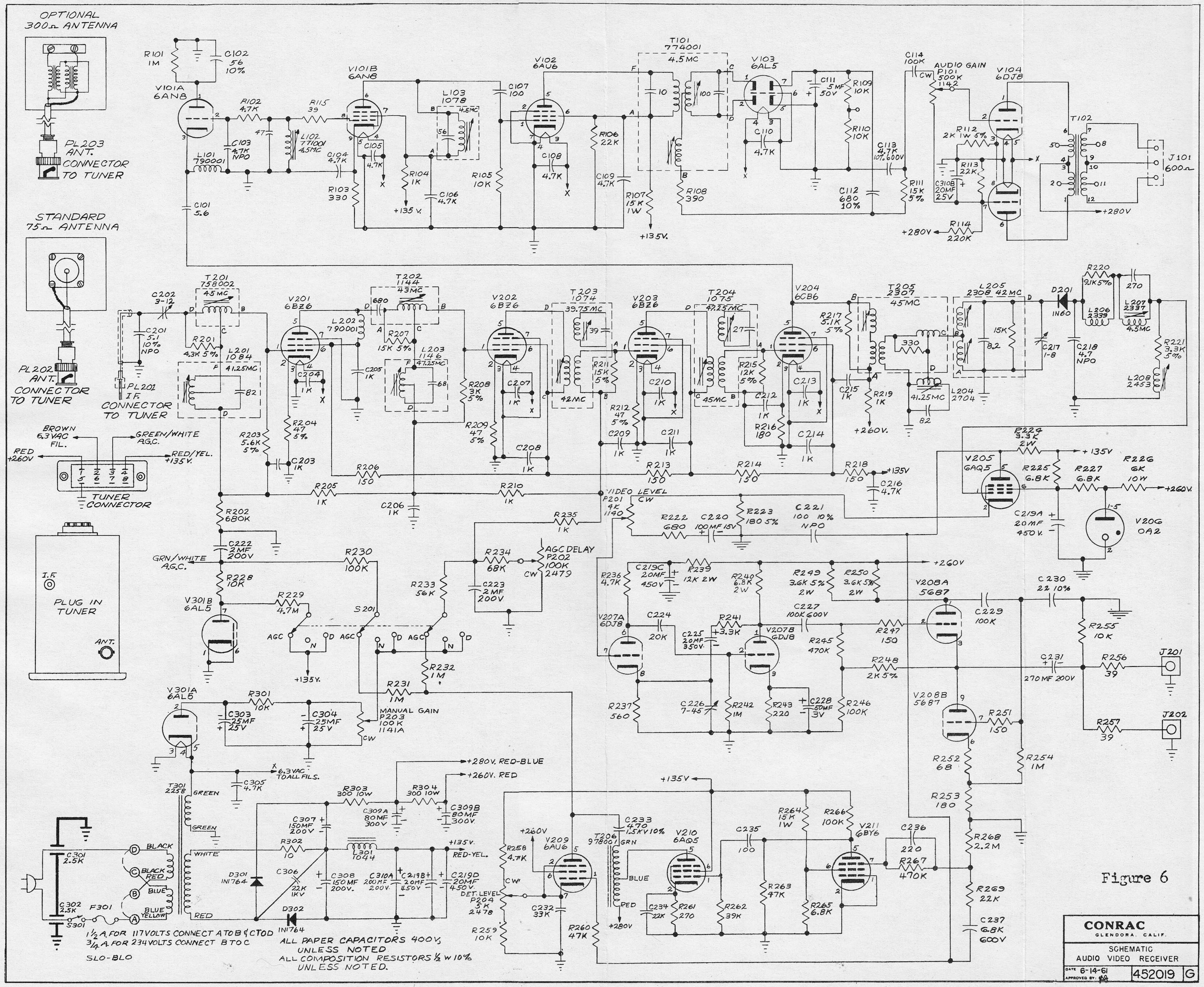

OPTIONAL 300Ω ANTENNA
PL203 ANT. CONNECTOR TO TUNER
STANDARD 75Ω ANTENNA
PL202 ANT. CONNECTOR TO TUNER
PL201 I.F. CONNECTOR TO TUNER
TUNER CONNECTOR
BROWN 6.3VAC FIL.
GREEN/WHITE A.G.C.
RED +260V
RED/YEL. +135V.
PLUG IN TUNER
I.F.
ANT.
GRN/WHITE A.G.C.
V101A 6AN8
V101B 6AN8
V102 6AU6
V103 6AL5
V104 6DJ8
T101 774001 4.5MC
T102
J101 600Ω
AUDIO GAIN P101 500K 1142
T201 758002 43MC
T202 1144 43MC
T203 1074 39.75MC
T204 1075 47.25MC
T205 2307 45MC
L205 2308 42MC
V201 6BZ6
V202 6BZ6
V203 6BZ6
V204 6CB6
V205 6AQ5
V206 0A2
D201 1N60
VIDEO LEVEL P201 4K 1140
AGC DELAY P202 100K 2479
MANUAL GAIN P203 100K 1141A
V301A 6AL5
V301B 6AL5
S201
AGC
V207A 6DJ8
V207B 6DJ8
V208A 5687
V208B 5687
J201
J202
T301 2258
C301 2.5K
C302 2.5K
F301
S301
L301 1044
D301 IN1764
D302 IN1764
+280V. RED-BLUE
+260V. RED
+135V. RED-YEL.
6.3VAC TO ALL FILS.
DET. LEVEL P204 2K 2478
V209 6AU6
T206 978001
V210 6AQ5
V211 6BY6
1½ A. FOR 117 VOLTS CONNECT A TO B & C TO D
¾ A. FOR 234 VOLTS CONNECT B TO C
SLO-BLO
ALL PAPER CAPACITORS 400V, UNLESS NOTED
ALL COMPOSITION RESISTORS ½ W 10% UNLESS NOTED.
CONRAC
GLENDORA, CALIF.
SCHEMATIC
AUDIO VIDEO RECEIVER
DATE 6-14-61
452019 G

Figure 6

The second I.F. coupling network is a standard bifilar-wound coil tuned to approximately 42 mc. A coupled trap tuned to 39.75 mc. rejects upper adjacent channel picture information. The third I.F. coupling network is tuned to approximately 45 mc. with a coupled trap tuned to approximately 45 mc. with a coupled trap tuned to 47.25 mc. for rejection of lower channel sound interference.

The coupling network between the fourth I.F. amplifier and the video detector provides over 30 db of attenuation for the 41.25 mc. accompanying sound component and has an essentially flat response from 41.75 mc. to 45 mc. The input section of the filter is tuned to 45 mc. and the output section is tuned near 42 mc. The sections are coupled by a bridged "T" network which rejects 41.25 mc. A crystal detector is used rather than a thermionic diode to provide optimum linearity and reduce capacitive loading. The four-stage I.F. amplifier has a converter grid sensitivity of 75 db.

Video Amplifier

A series connected trap located in the video detector output circuit is tuned to 4.5 mc. to reject any spurious beats between sound and picture carriers.

The first video amplifier is connected as a cathode follower to drive

the VIDEO LEVEL control and also as a conventional video amplifier to drive the keyed AGC system.

The second video amplifier is connected as a "feedback pair." This amplifier has a maximum gain of about four times, and is flat to approximately 10 mc. The output stage combines the advantage of a cathode follower with a plate-loaded amplifier to minimize differential gain and phase direction.

Keyed AGC System

Video information from the plate of the first video amplifier stage is fed to a sync stripper. Stripped sync is amplified and fed through a pulse transformer to the AGC keyer tube.

Video level information is supplied to the control grid of the AGC keyer tube. A negative voltage which is proportional to the peak carrier level is then developed. An adjustable fraction of this voltage is supplied to the grid return of the first three I.F. amplifiers. A portion is also supplied to the first R.F. amplifier grid through a suitable delay and clamping network. The AGC voltage will maintain the peak video voltage at the detector at a constant level over an extremely wide range of input signal strengths.

Audio Circuit

Sound information is removed at the plate of the last video I.F.

amplifier. At this point, the level of the sound carrier component is about 26 db below the picture component of the signal, which is the optimum ratio for intercarrier sound detection. The sound signal is converted to 4.5 mc. with a diode, and fed through a two-stage 4.5 mc. amplifier to a ratio detector. The second state of the 4.5 mc. amplifier functions as a limiter, which in conjunction with the ratio detector, gives excellent rejection of amplitude modulation. A cathode coupled push-pull audio output stage is used to drive a high quality output transformer.

2. Modifications made to basic receiver for aural and visual monitoring functions

As indicated above several modifications to the basic receiver were made in order that the operating parameters could be visually observed and monitored. These included the removal of the audio component for measuring the percentage of aural modulation and the insertion of white reference keying pulses for measuring certain characteristics of the video signal.

a. Aural

There was no attempt made to remote the main aural percentage of modulation meter since it was felt that an equal degree of accuracy and greater simplicity could be achieved by utilizing the audio circuitry in the Conrac receiver for this function.

The audio signal was fed before de-emphasis from the junction of R-111 and C-112 in the Conrac receiver to a percentage of modulation meter, rather than a VU meter. The meter and its associated circuitry had the same band-pass and ballistic characteristics as that adopted for aural FM modulation meters. This meter was then calibrated to track exactly with the modulation meter associated with the regular modulation monitor. In addition, the normal audio output terminals J101 of the Conrac receiver were connected to the customary monitor amplifier and speaker. This included the de-emphasis network already in the receiver.

b. Visual

In visual monitoring, the video output was observed on a Tektronix Model 525 mod 111 scope and picture monitor which were connected to the normal Conrac video output terminals J-201 and J-202.

A coax input jack was added to the Conrac receiver into which a white reference keying pulse generator was fed. This generator produces a negative pulse for turning off the plate current in the last I.F. amplifier.

Since the network and some local stations insert a Vertical Interval Test (VIT) signal into lines 15 through 17 of each vertical blanking

pulse, the white reference pulse generator is adjusted to be either before the 15th line or after the 17th line. When the TV transmitter is being properly modulated, the VIT signal will have a white peak of 12 1/2% of peak sync (100%) level. The receiver white reference level completely turns off the receiver to produce 0% of peak sync (100%) level. The waveform monitor was calibrated and displayed the following parameters:

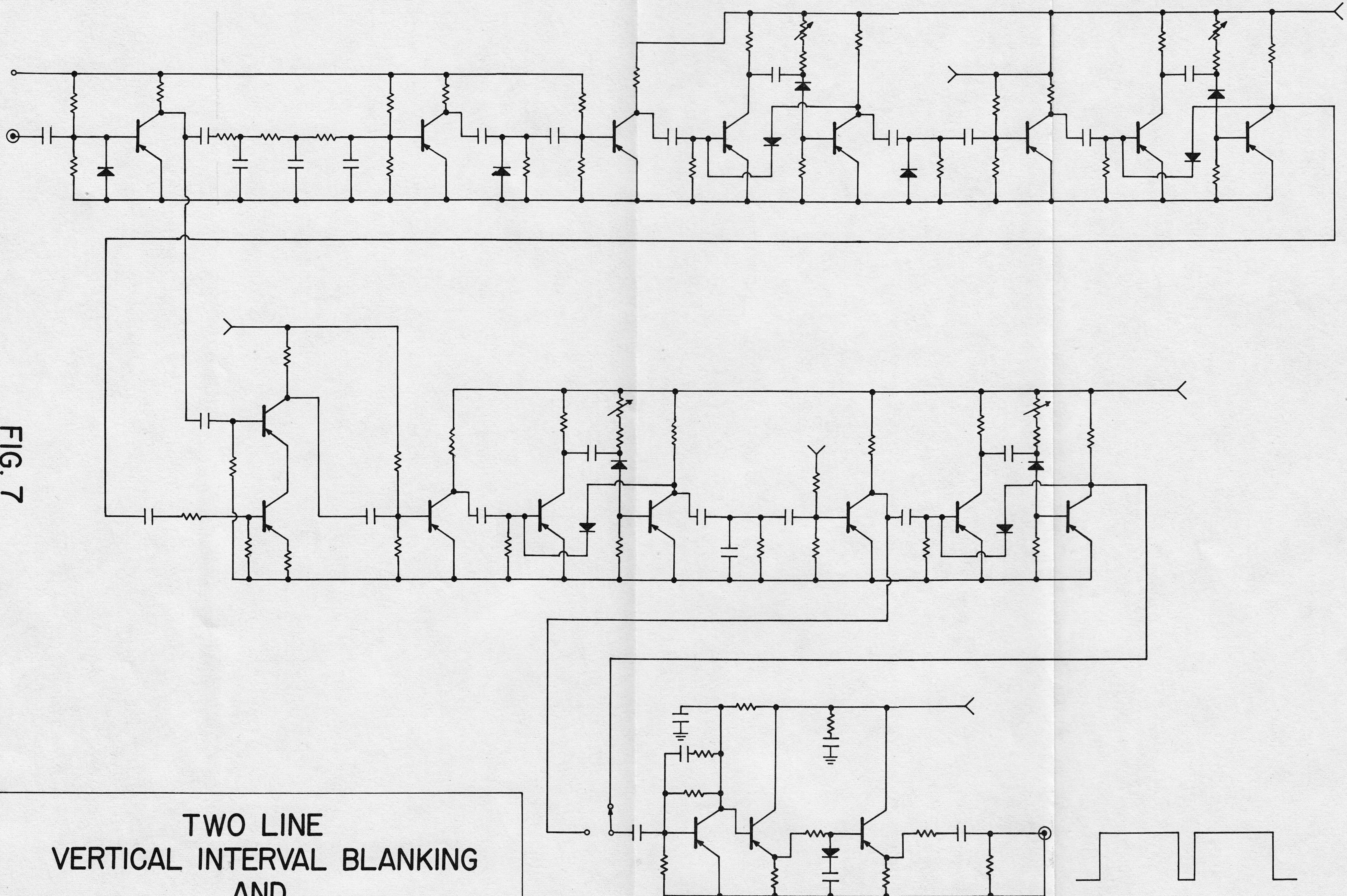
100%	Sync level
75%	Black level
12 1/2%	Peak white level
0%	Reference white level

Figure 7 is the schematic diagram of the transistorized generator whose output was fed into the Conrac receiver.

Alarms

Since the receiver is designed for inter-carrier operation, this feature was used to advantage for a visual or aural carrier failure alarm sensor. The alarm circuit was developed by amplifying the DC component of the grid voltage associated with the receivers aural I.F. limiter stage. When no signal was present on the aural I.F. of the intercarrier receiver, either visual or aural, the lack of bias would then activate the "off-air" alarm circuit.

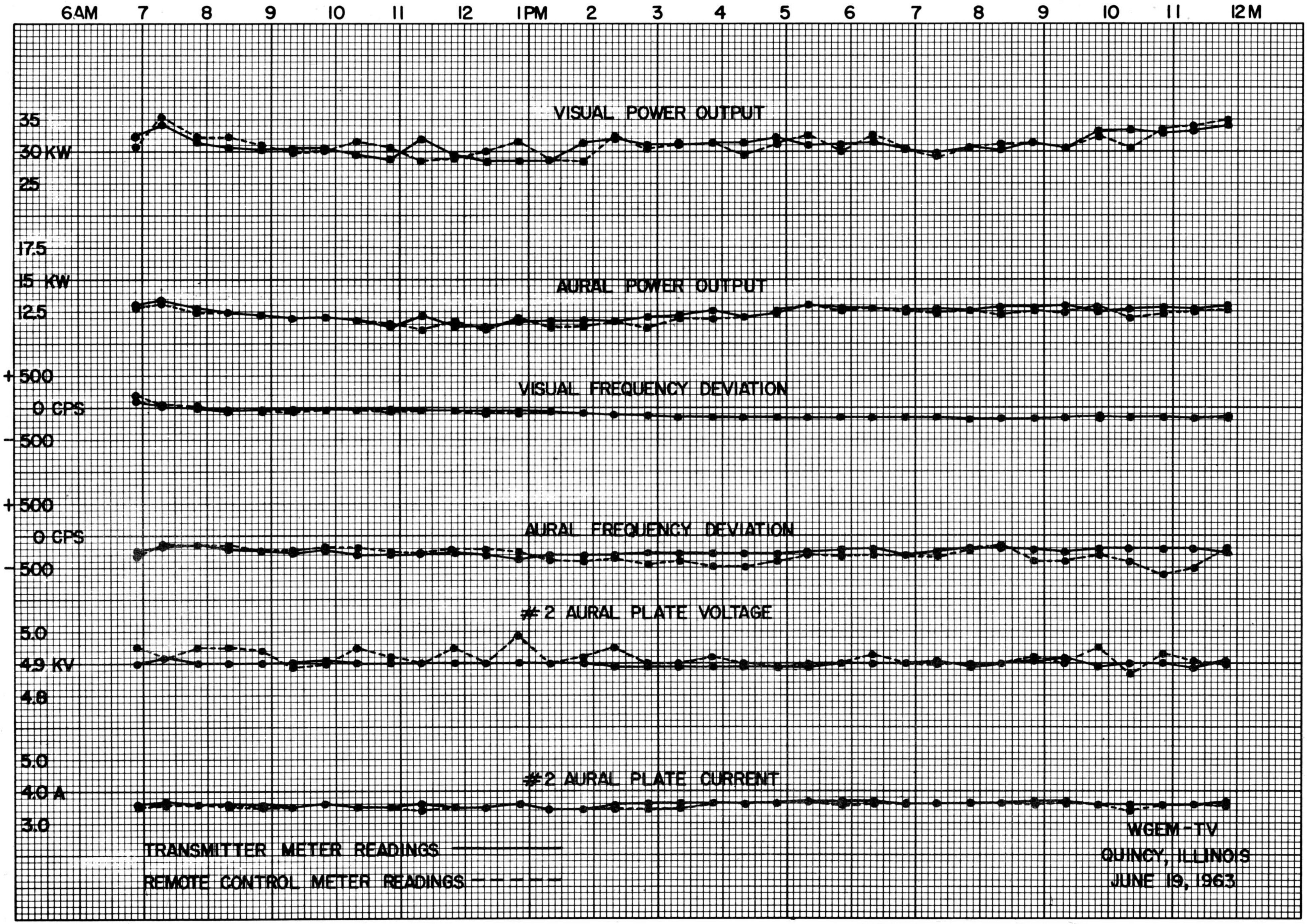
FIG. 7



TWO LINE
VERTICAL INTERVAL BLANKING
AND
CAL PULSE GENERATOR

METERING OBSERVATIONS

In the following graphs, the remote control readings are compared to the readings taken at the transmitter and recorded in the transmitter log. The graphs shown herein are a representative sampling of the data obtained during the course of the entire experiment. Since the aural transmitter has two final stages, the plate voltage and current data has been plotted for each transmitter on alternate graphs.



6AM
7
8
9
10
11
12
1PM
2
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4
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6
7
8
9
10
11
12M
VISUAL POWER OUTPUT
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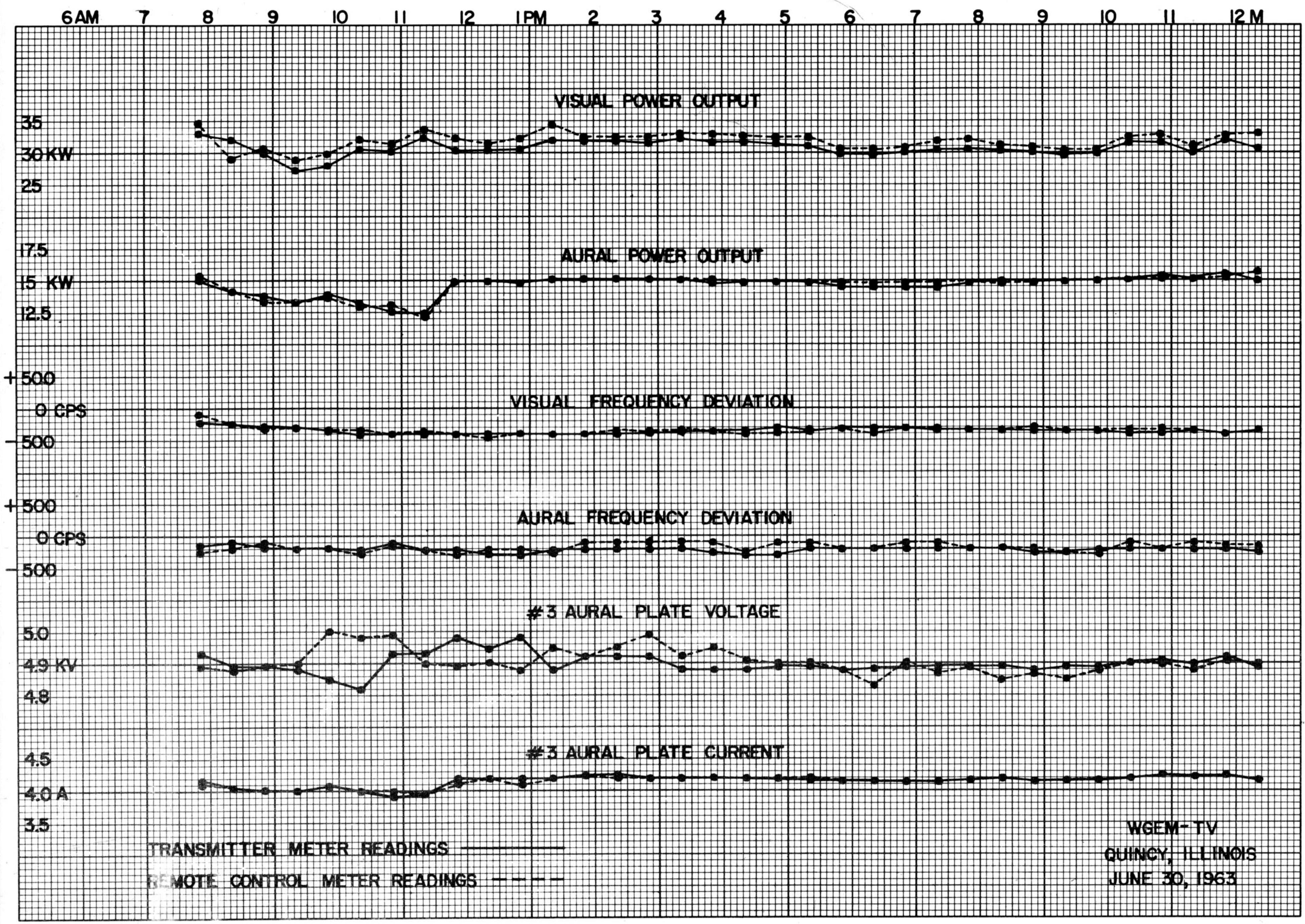
30 KW
25
17.5
15 KW
AURAL POWER OUTPUT
12.5
+500
VISUAL FREQUENCY DEVIATION
0 CPS
-500
+500
0 CPS
AURAL FREQUENCY DEVIATION
-500
#2 AURAL PLATE VOLTAGE
5.0
4.9 KV
4.8
5.0
#2 AURAL PLATE CURRENT
4.0 A
3.0
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
JUNE 19, 1963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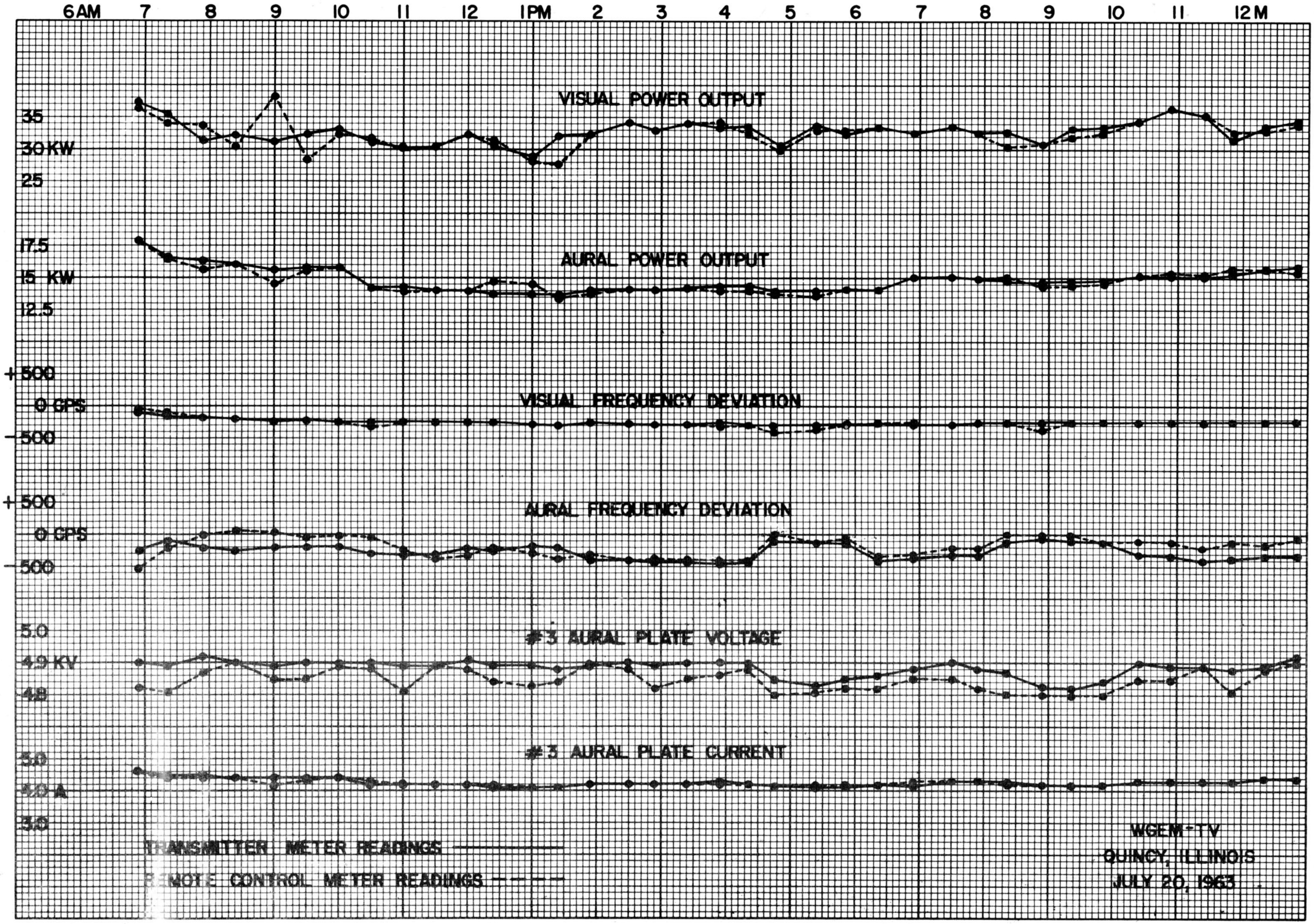
VISUAL POWER OUTPUT
35
30 KW
25
AURAL POWER OUTPUT
17.5
15 KW
12.5
VISUAL FREQUENCY DEVIATION
+500
0 CPS
-500
AURAL FREQUENCY DEVIATION
+500
0 CPS
-500
#3 AURAL PLATE VOLTAGE
5.0
4.9 KV
4.8
#3 AURAL PLATE CURRENT
4.5
4.0 A
3.5
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
JUNE 30, 1963



6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12M
VISUAL POWER OUTPUT
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AURAL POWER OUTPUT
17.5
15 KW
12.5
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#3 AURAL PLATE VOLTAGE
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4.9 KV
4.8
#3 AURAL PLATE CURRENT
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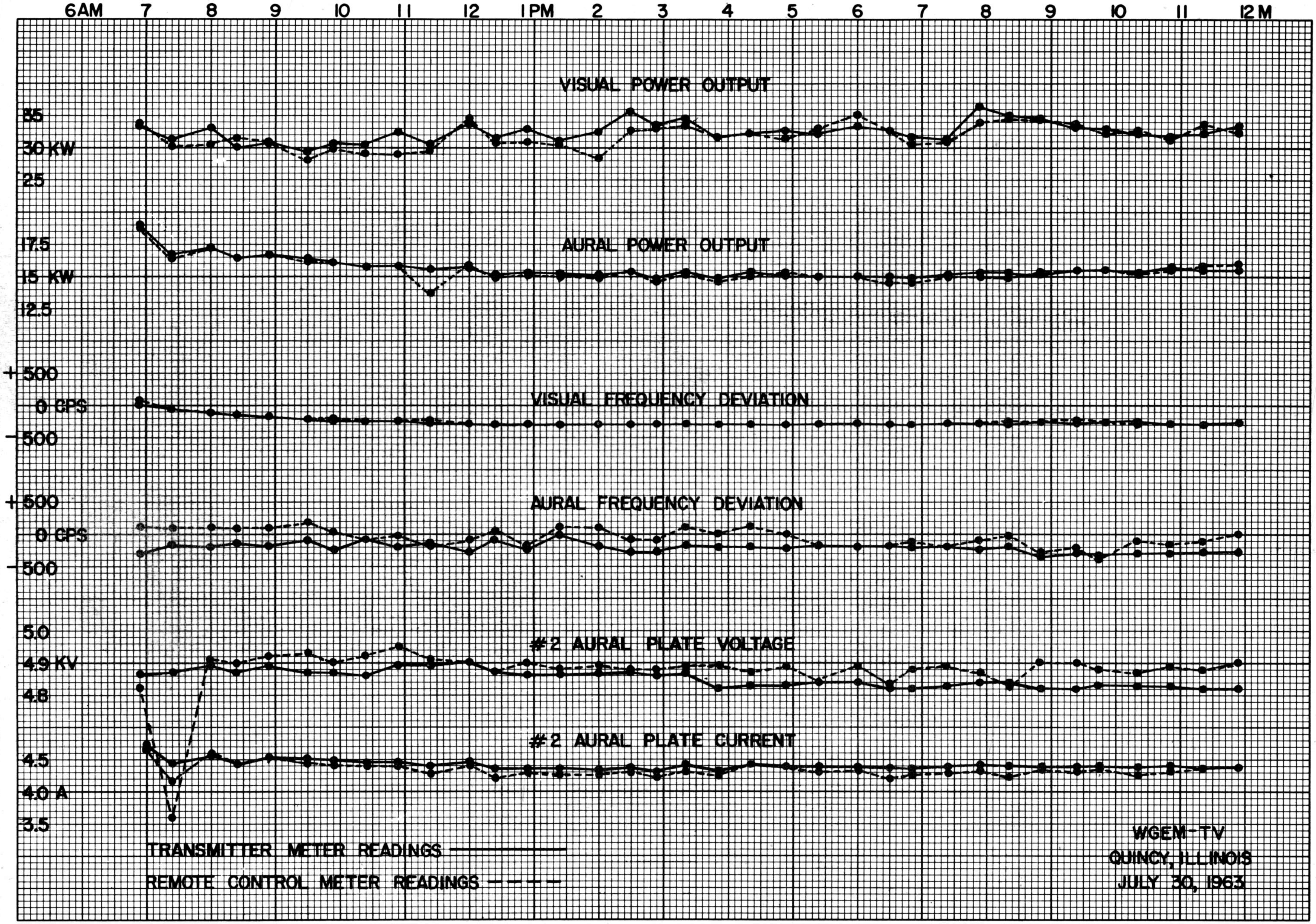
4.0 A
3.0
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
JULY 20, 1963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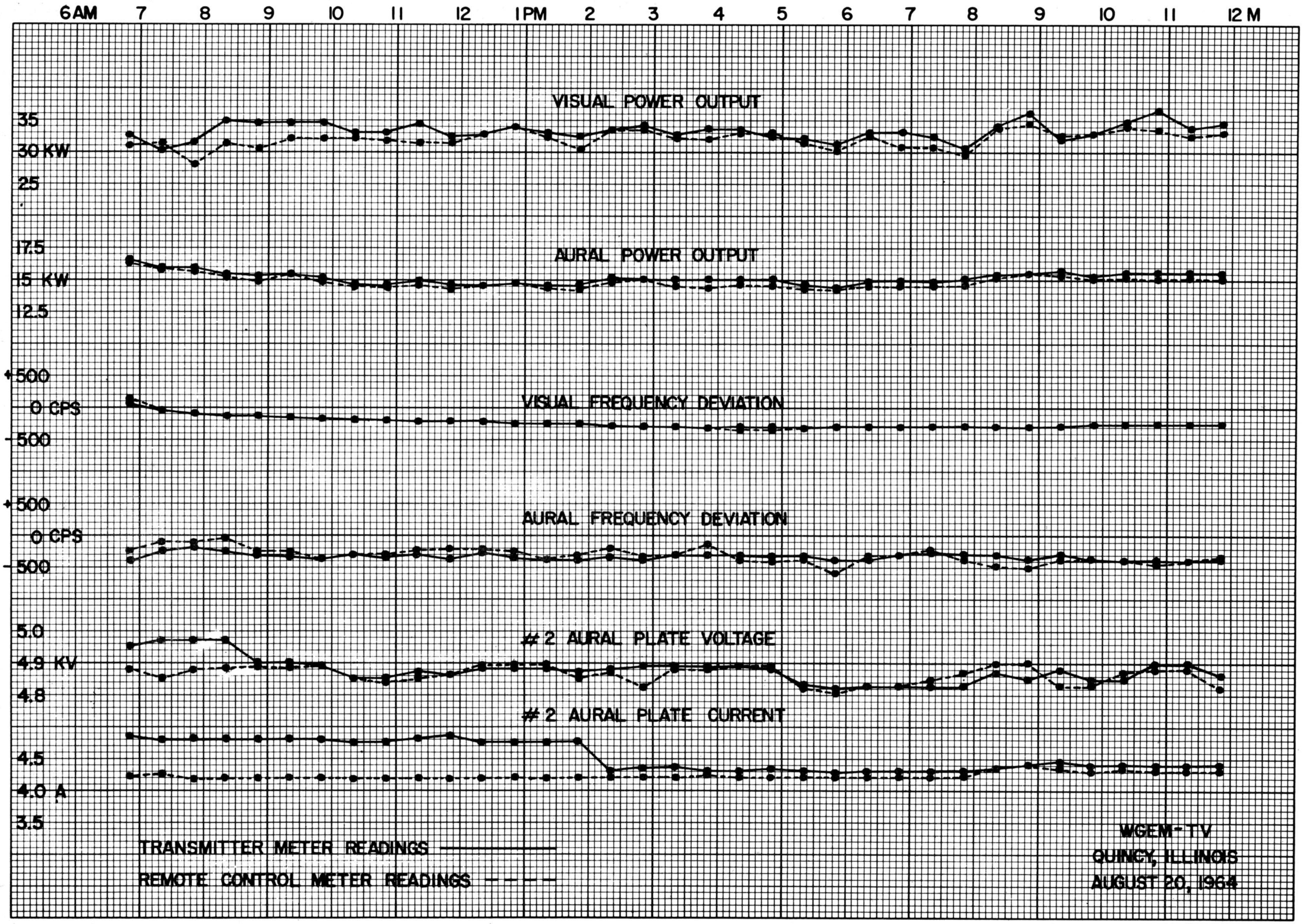
VISUAL POWER OUTPUT
35
30 KW
25
AURAL POWER OUTPUT
17.5
15 KW
12.5
VISUAL FREQUENCY DEVIATION
+500
0 CPS
-500
AURAL FREQUENCY DEVIATION
+500
0 CPS
-500
#2 AURAL PLATE VOLTAGE
5.0
4.9 KV
4.8
#2 AURAL PLATE CURRENT
4.5
4.0 A
3.5
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
JULY 30, 1963



6 AM
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2 AURAL PLATE CURRENT
4.5
4.0 A
3.5
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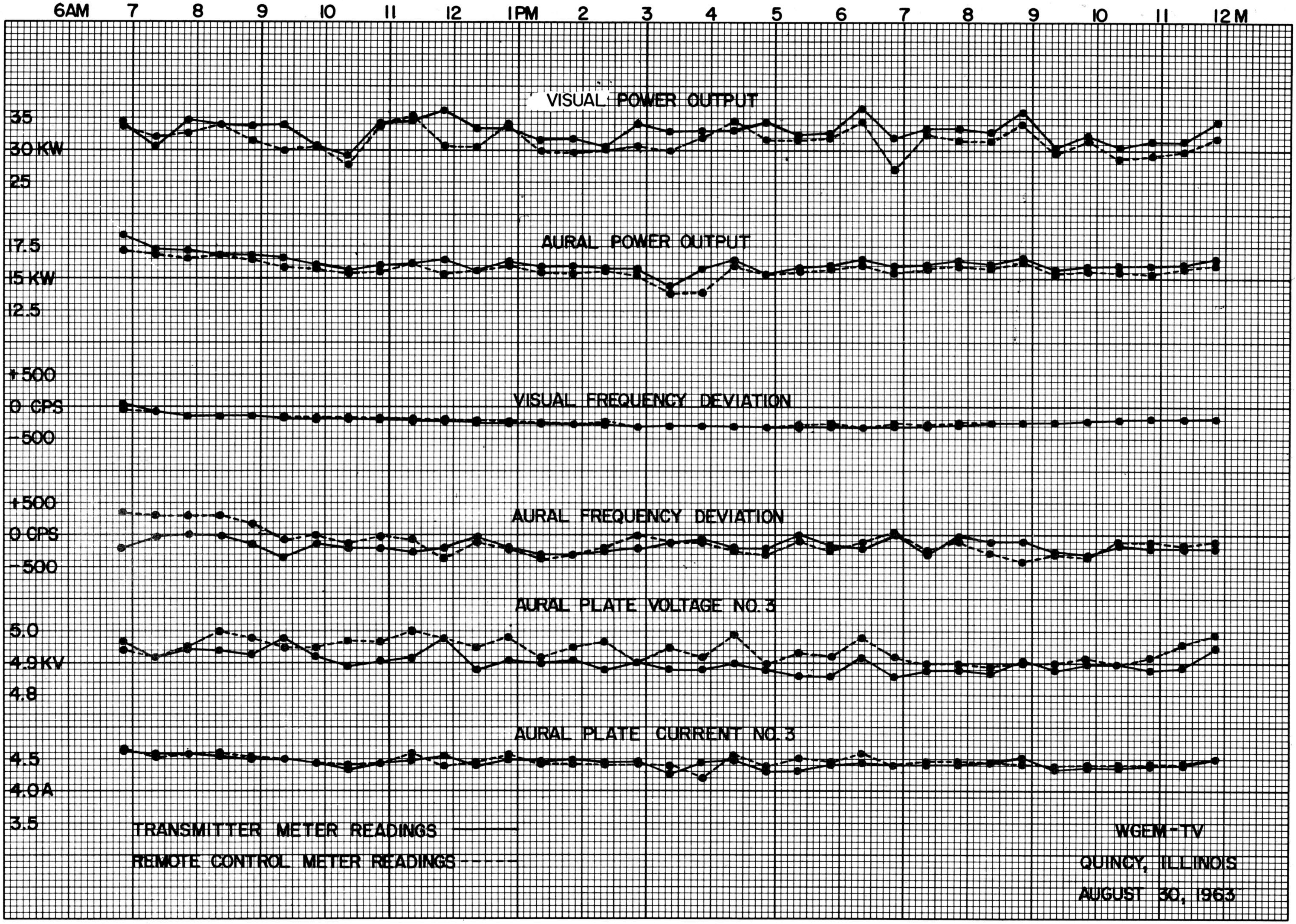
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
AUGUST 20, 1964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VISUAL POWER OUTPUT
35
30 KW
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AURAL POWER OUTPUT
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VISUAL FREQUENCY DEVIATION
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AURAL FREQUENCY DEVIATION
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5.0
4.9 KV
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4.5
4.0A
3.5
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
AUGUST 30, 1963

NO. 340R-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

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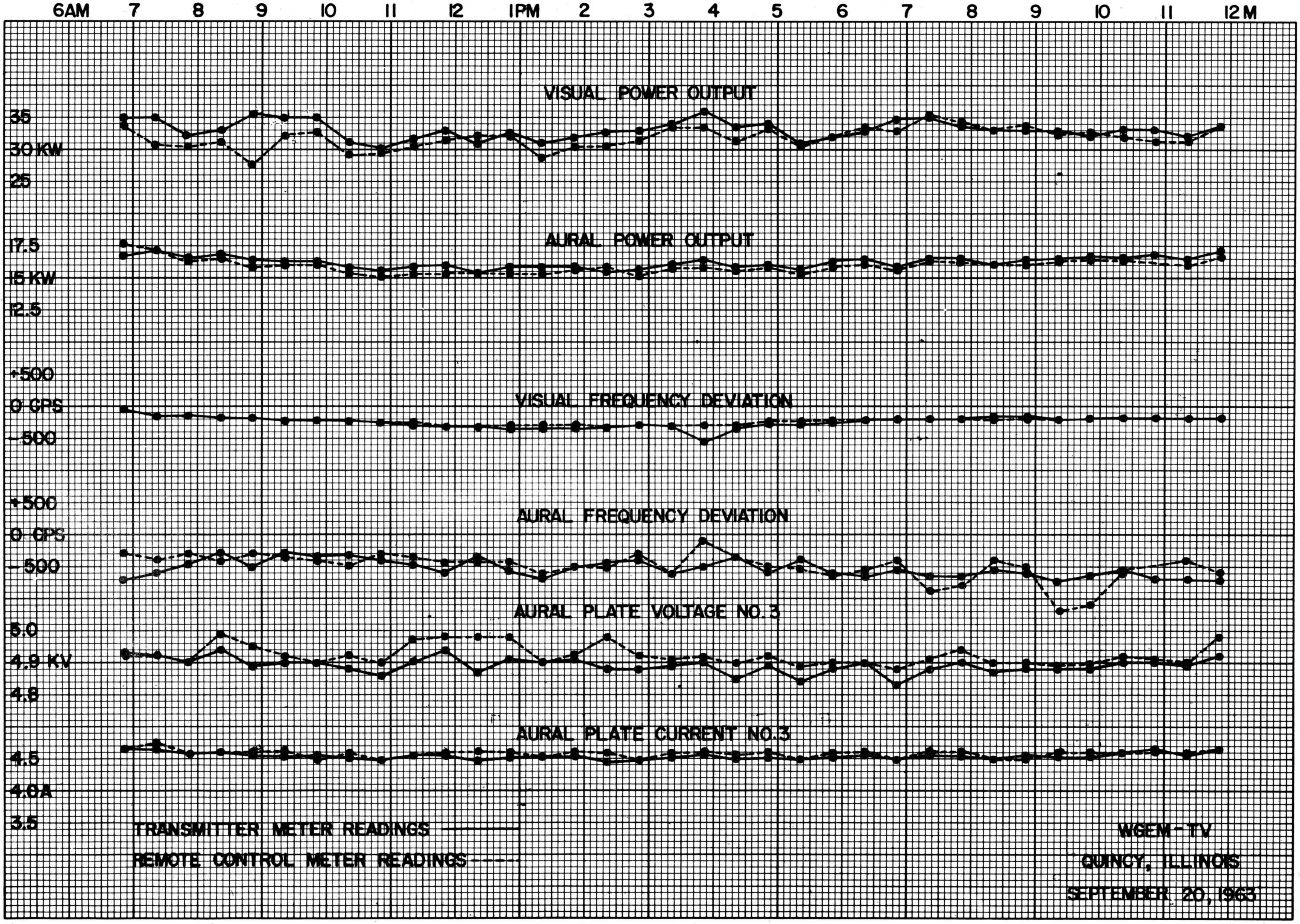
MADE IN U. S. A.



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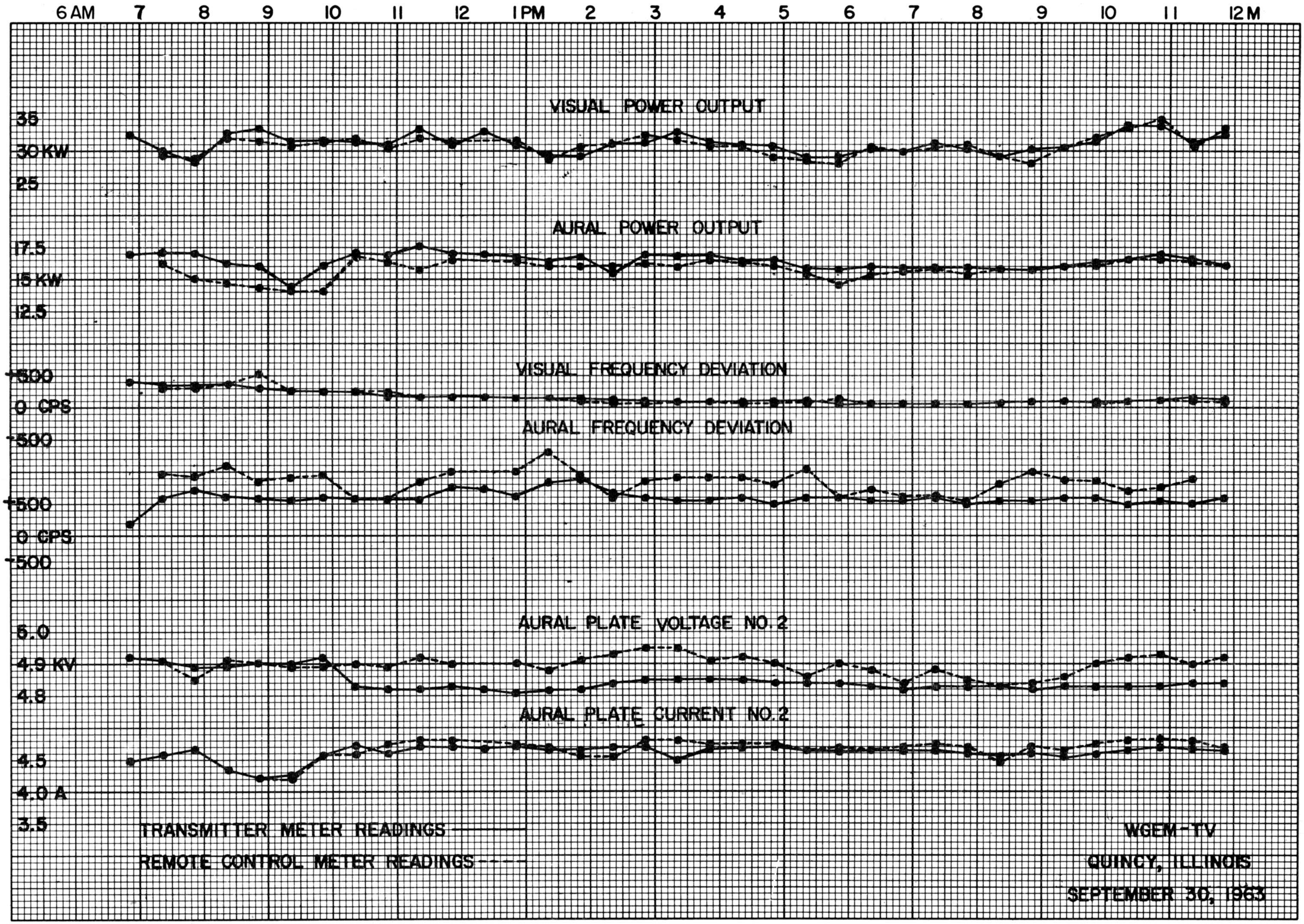
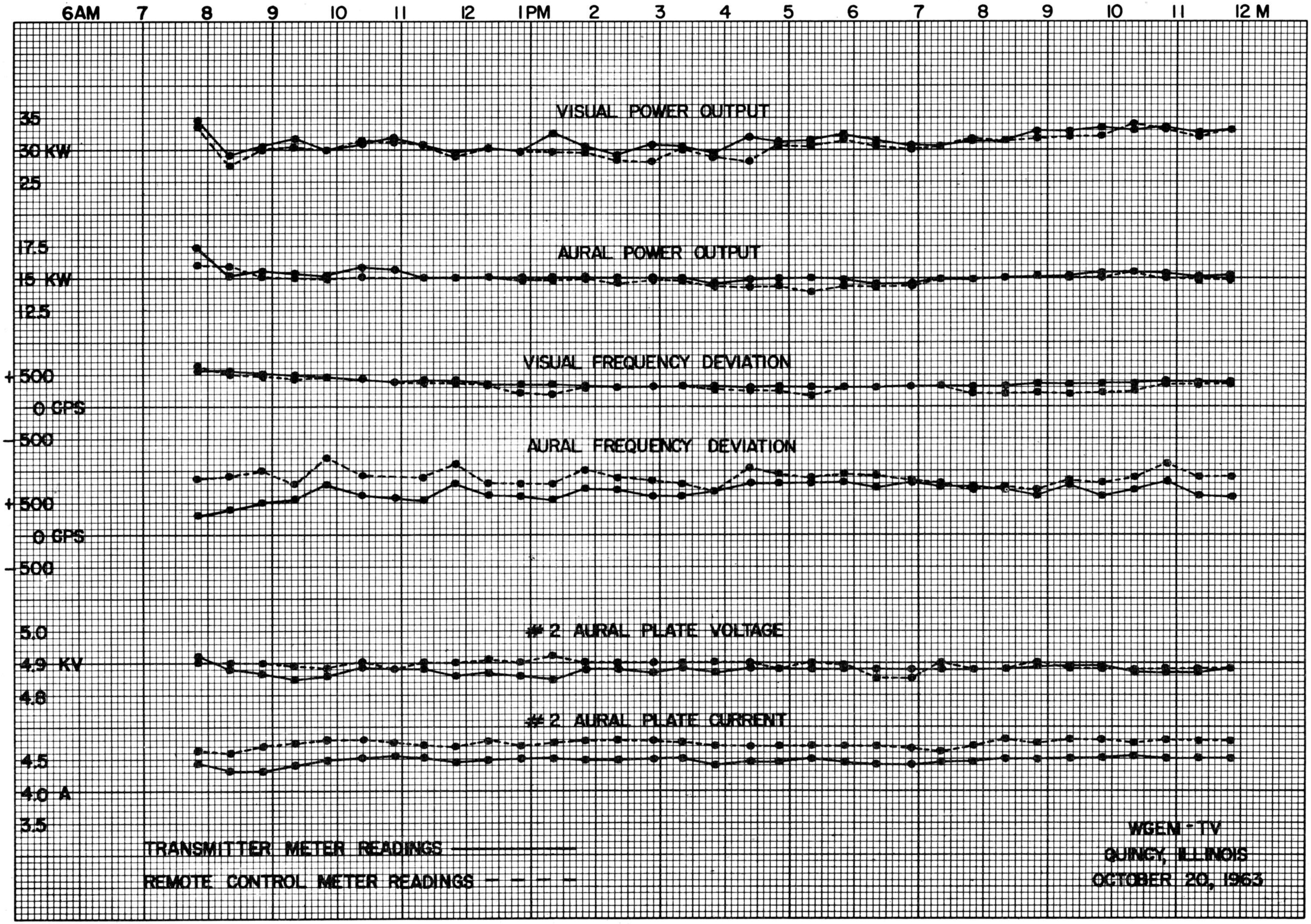


- 154 -



6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12 M
VISUAL POWER OUTPUT
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0 CPS
-500
2 AURAL PLATE VOLTAGE
5.0
4.9 KV
4.8
2 AURAL PLATE CURRENT
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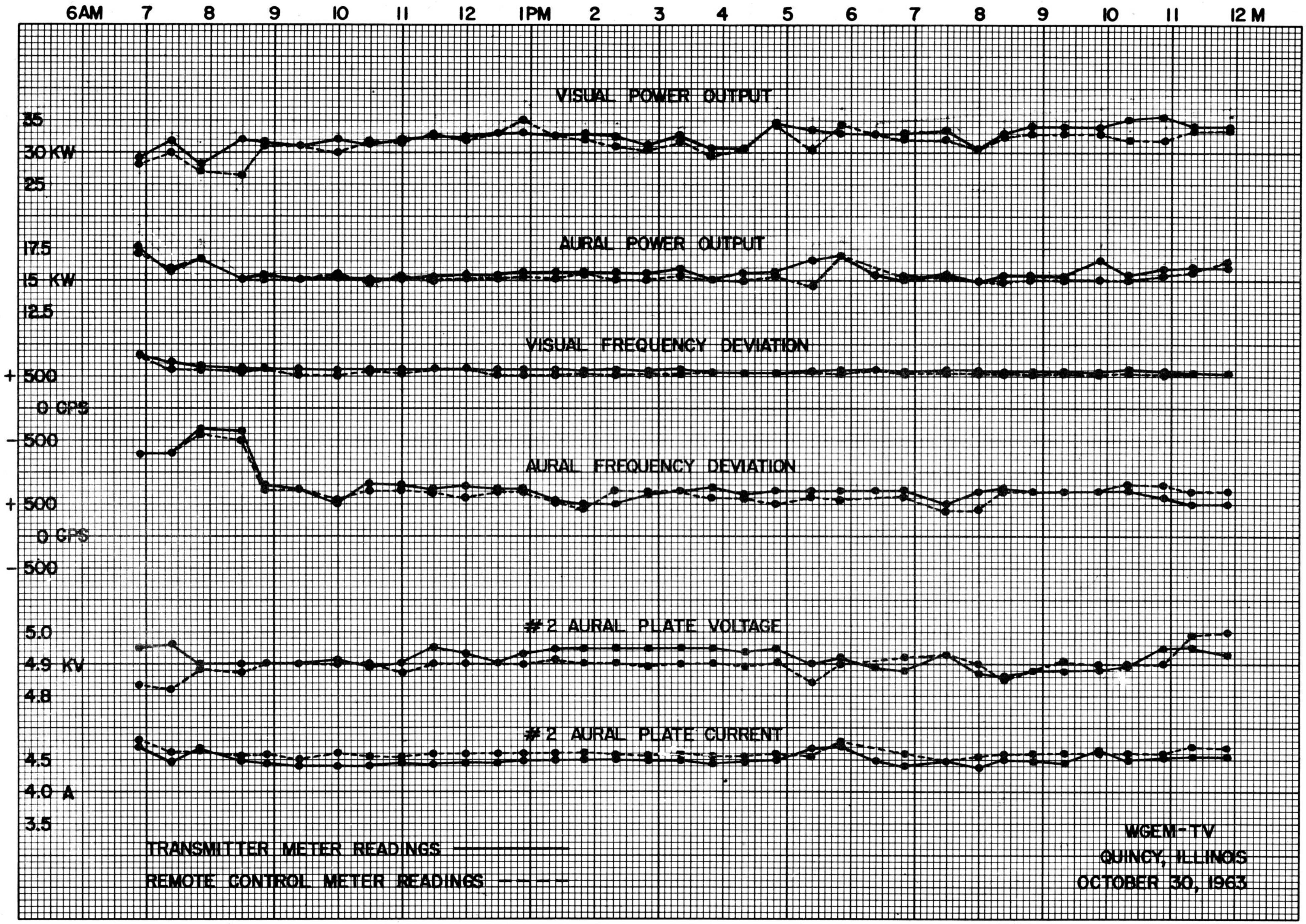
3.5
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM - TV
QUINCY, ILLINOIS
OCTOBER 20, 1963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VISUAL POWER OUTPUT
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25
AURAL POWER OUTPUT
17.5
15 KW
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- 500
#2 AURAL PLATE VOLTAGE
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4.9 KV
4.8
#2 AURAL PLATE CURRENT
4.5
4.0 A
3.5
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WGEM-TV
QUINCY, ILLINOIS
OCTOBER 30, 1963

SUMMARY OF RESULTS OF WGEM-TV REMOTE CONTROL EXPERIMENT

The tests at WGEM-TV were conducted over a five-month period. During that time the control, metering and monitoring system operated trouble-free. Once the system had been properly installed and calibrated, the remote control functions operated faultlessly and the remote meter readings corresponded reasonably with those readings taken manually at the transmitter.

The results of these tests at WGEM-TV prove conclusively that a VHF-TV transmitter can be remotely controlled and monitored without any degradation to equipment and technical performance. The equipment used in these tests is reliable and is flexible to the degree that the system can be contracted or expanded to meet the needs of any broadcaster.

REMOTE CONTROL EXPERIMENT

WABI-TV

Bangor, Maine

INTRODUCTION

WABI-TV is licensed to the Community Telecasting Company and operates on Channel 5 assigned to Bangor, Maine. The studios are located at 35 Hildreth Street, Bangor, Maine, and the transmitter approximately 10 miles northwest of the city. (Coordinates N 44-44-16, W 68-42-00). The station is authorized to operate with a visual power of 29.5 kw ERP at a height of 670 feet above average terrain.

For purposes of this experiment, WABI-TV cooperated with the Rust Corporation of America, who supplied both the control and automatic logging equipment. Since the remote control system operated over wire lines, no experimental authorization was required; however, the Commission was informally notified of these tests by letter. The tests were carried out between the period of July 1 and October 30, 1964.

The holder of a First-Class Radiotelephone license was present at the transmitter during all periods of operation as required by Section 73.661 of the Rules. A regular transmitter log was maintained and the transmitter was under the immediate supervision of a First-Class Radiotelephone license holder at all times. A telephone talkback circuit was in service between the transmitter and remote control point and the system was calibrated weekly.

Control and metering functions between the studio (remote control point) and transmitter was achieved by two leased telephone lines, each of 2200 ohms, which were supplied by the New England Telephone and Telegraph Company. It should be noted that these lines were of very poor quality, and large filters had to be installed on each end to remove constant fluctuations.

DESCRIPTION OF TRANSMITTER

General

Station WABI-TV utilizes an RCA TT-10AL transmitter designed for television stations with effective radiated power requirements ranging from 10 to 100 Kilowatts. This is a high-level modulated, air-cooled television broadcast transmitter and provides a nominal power output of 11 kilowatts peak visual power, as measured at the output of the sideband filter or filterplexer, and 6 kilowatts aural power, in conformance with FCC Standards.

The transmitter, except for two external plate transformers, is housed in six identical cubicles. These cabinets are mounted adjacent to each other on rails which serve not only as a common base frame but also as wire trenches. Sliding front doors are utilized on all cubicles.

REMOTE CONTROL SYSTEM

Introduction

The remote control equipment used during these tests was a standard Rust Type D system. The system consists of the following two units:

a) Studio

b) Transmitter

Both units are interconnected by two metallic telephone lines the resistance of which can be as high as 4000 ohms. One pair of lines are used for control voltages and pulses; the other pair for metering. The system can remotely control and meter 24 functions and control can be applied to any function where relays or reversible motors can be used.

The control system depends upon the unique temporal characteristics of the several relays used in the system. Two basic types of relays are used:

a) Fast acting

b) Slow release

In addition, "raise-lower" operation is made possible by the magnitude of the control voltage sent to the transmitter unit by the studio system to relays of different sensitivity. Remote metering is achieved by the conventional method of converting the sampled parameter to a very low DC voltage.

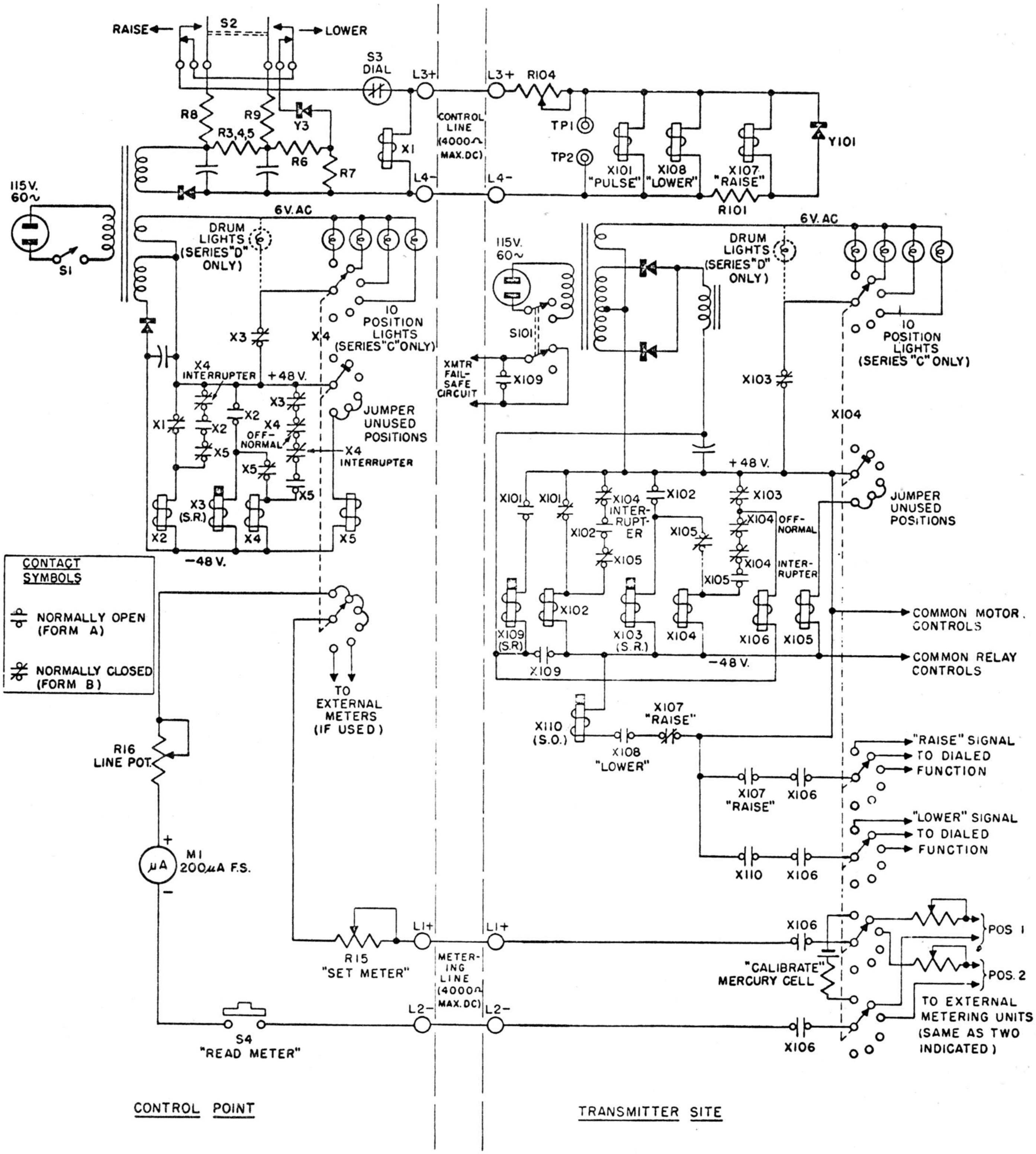
This in turn is fed to the metering read-out unit through a selective relay system.

System Description

The following is a brief operational description of the system and can be best understood by reference to Figure 1 (Simplified Elementary Diagram).

A. Control Line Circuit

1. Control line operates three parallel relays X101, X108 and X107.
2. Potentiometer R104 compensates for various line resistances. Set to get 5V. DC at test points.
3. Relay X101 is picked up when S1 is closed and energizes X109.
4. Slow release relay X109 stays picked up during dialing and maintains power to rest of relays and fail safe circuit.
5. Relay X101 follows dial pulses to operate transmitter stepping circuit.
6. Relay X108 operates in addition to X101 when "lower" voltage is on line.



SIMPLIFIED ELEMENTARY DIAGRAM

RUST REMOTE CONTROL-SERIES "C" AND "D"

FIG. 1

7. Relay X107 operates in addition to X101 and X108 when "raise" voltage is on line.
8. Rectifier Y101 makes X107 drop out after X108 when switching from "raise" to "normal".

B. Transmitter Stepping Circuit

1. Relays X102, X103, X104, X105 operate identically to X2, X3, X4, and X5 as described under "Local Stepping Circuit".
2. Relay X106 is de-energized during dialing by X103 and disables all transmitter metering and control functions during dialing, thus providing protection to stepper contacts and preventing operator switching errors.

C. Raise Lower Control

1. "Lower" relay X108 energizes slow operate relay X110 except when X107 is also energized.
2. X110 prevents false "lower" signal when switching from "normal" to "raise".
3. Two banks of X104 stepper connect "raise" and "lower" signals to function selected by dialing.

4. X107 and X110 connect "raise" and "lower" banks respectively to + 48V. bus.
5. Barber-Colman motor shading pole coils may be shorted to cause motor operation by returning common leads to + 48V. bus.
6. 48 volt external relays may be operated by returning common leads to - 48V. bus.

D. <u>Metering Circuit</u>

1. The metering line is switched to various external metering units providing approximately a 0.5 volt DC metering sample.
2. Individual metering pots allow calibration of each remote reading.
3. Mercury cell and precision resistor provide line standardizing current in the "calibrate" position.

<u>Control</u>

It should be noted that due to the electrical/mechanical design of the transmitter, some limitations were imposed upon the remote control functions which were performed. The installation of reversible motors mounted on

existing potentiometer shafts was required but the actual use of such controls was not deemed electrically practical since, in many instances, any attempt to adjust circuit performance required the readjustment of other associated circuits. For example, the control of power output is accomplished electrically by adjusting excitation. Although this is a frontpanel adjustment, any changes in this control results in disturbing the electrical characteristics of the transmitter. Therefore, it was considered impractical to remotely control this function without making major electrical modifications to the transmitter which were deemed inadvisable at the time.

Due to the electrical limitations imposed upon this test, the following functions were remotely controlled:

On/raise	Off/lower
Aural filament on	Aural filament off
Aural plate on	Aural plate off
Visual filament on	Visual filament off
Visual plate on	Visual plate off
Auto log on	Auto log off
Manual Control on	Manual Control off

Figure 2 depicts the latching relay circuit associated with controlling the above functions.

Metering

Remote metering is accomplished by the use of conventional voltage

dropping resistive networks or the rectification of either RF or AC to direct current. A resultant potential acceptable to the remote control system and interconnecting metallic circuitry is used. The following parameters were remotely metered:

Position	Metering
1	Aural filament voltage
2	Aural plate voltage
3	Visual filament voltage
4	Visual plate voltage
5	Aural plate current
6	Aural forward power
7	Visual plate current
8	Visual forward power

Figure 3 depicts the circuitry employed in sampling the aural and visual filament voltage. Figure 4 is the sampling circuit associated with remotely obtaining the aural and visual plate current and voltage. In the matter of sampling the aural and visual power output, it was necessary to utilize a DC amplifier connected to the transmitter refectometer circuitry. The amplifier schematic is shown in Figure 5.

Figure 6 is a block diagram of the metering system associated with the manner and automatic logging of aural plate voltage, aural plate current, aural power output, and visual power output. It is representative of the method of remote metering associated with this portion of the field tests at station WABI-TV.

LATCHING RELAY SYSTEM USED TO CONTROL AURAL FILAMENT ON/OFF, AURAL PLATE ON/OFF, VISUAL FILAMENT ON/OFF AND VISUAL PLATE ON/OFF.

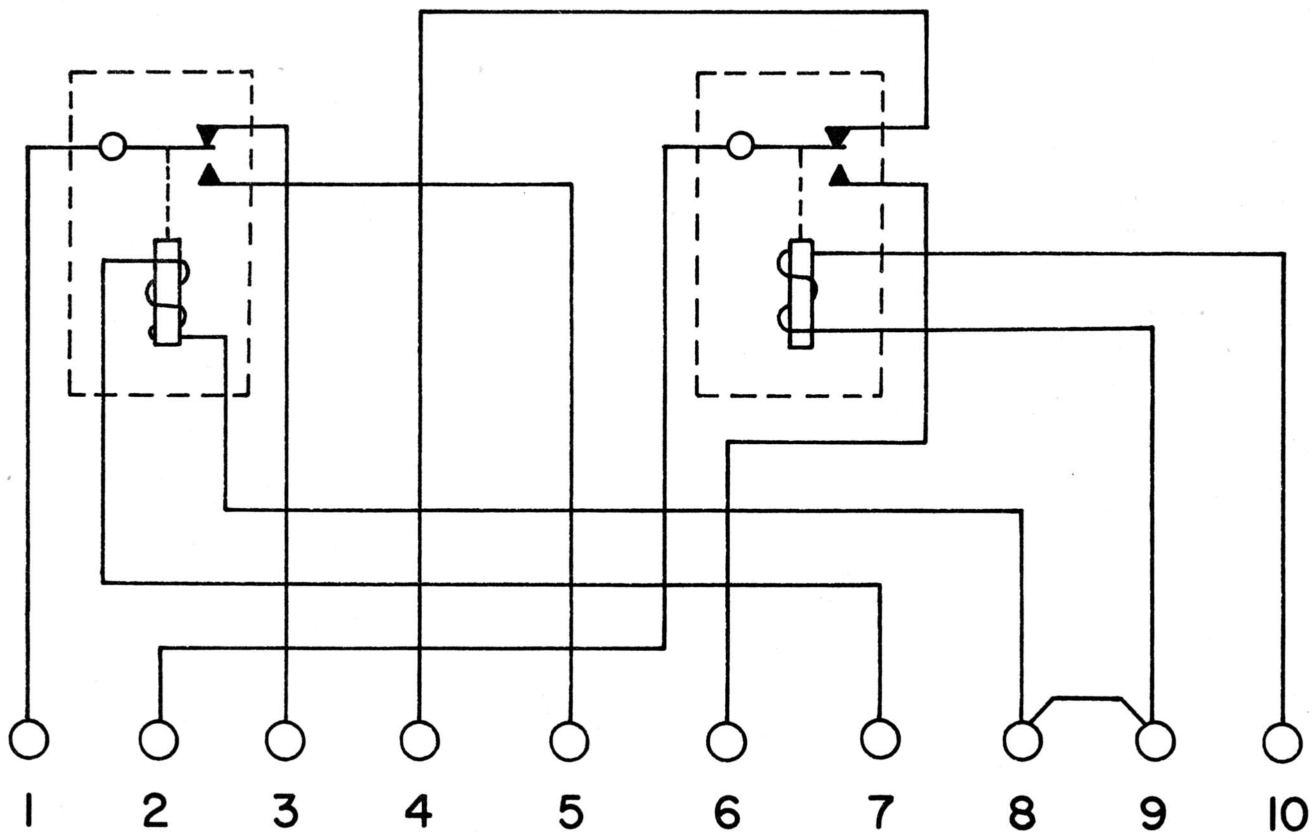
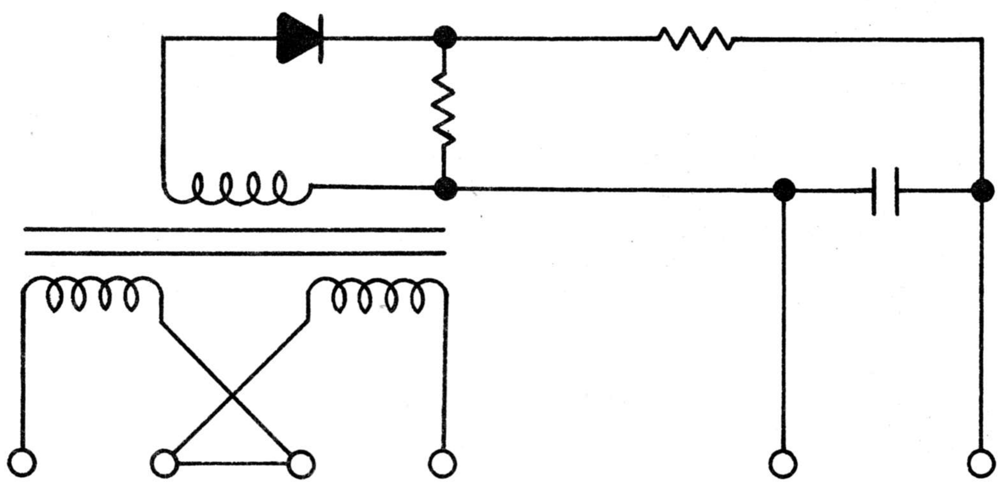


FIG. 2

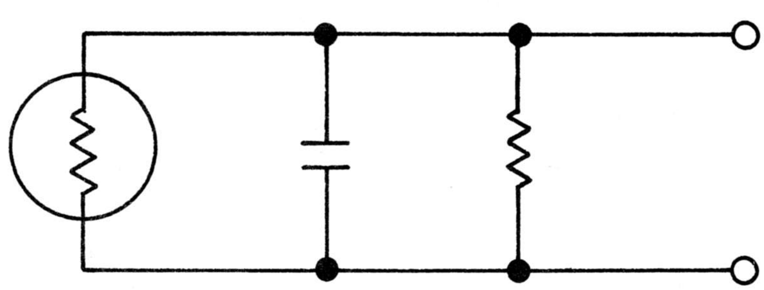
FILAMENT VOLTAGE SAMPLING CIRCUIT



TO REMOTE
METERING SYSTEM

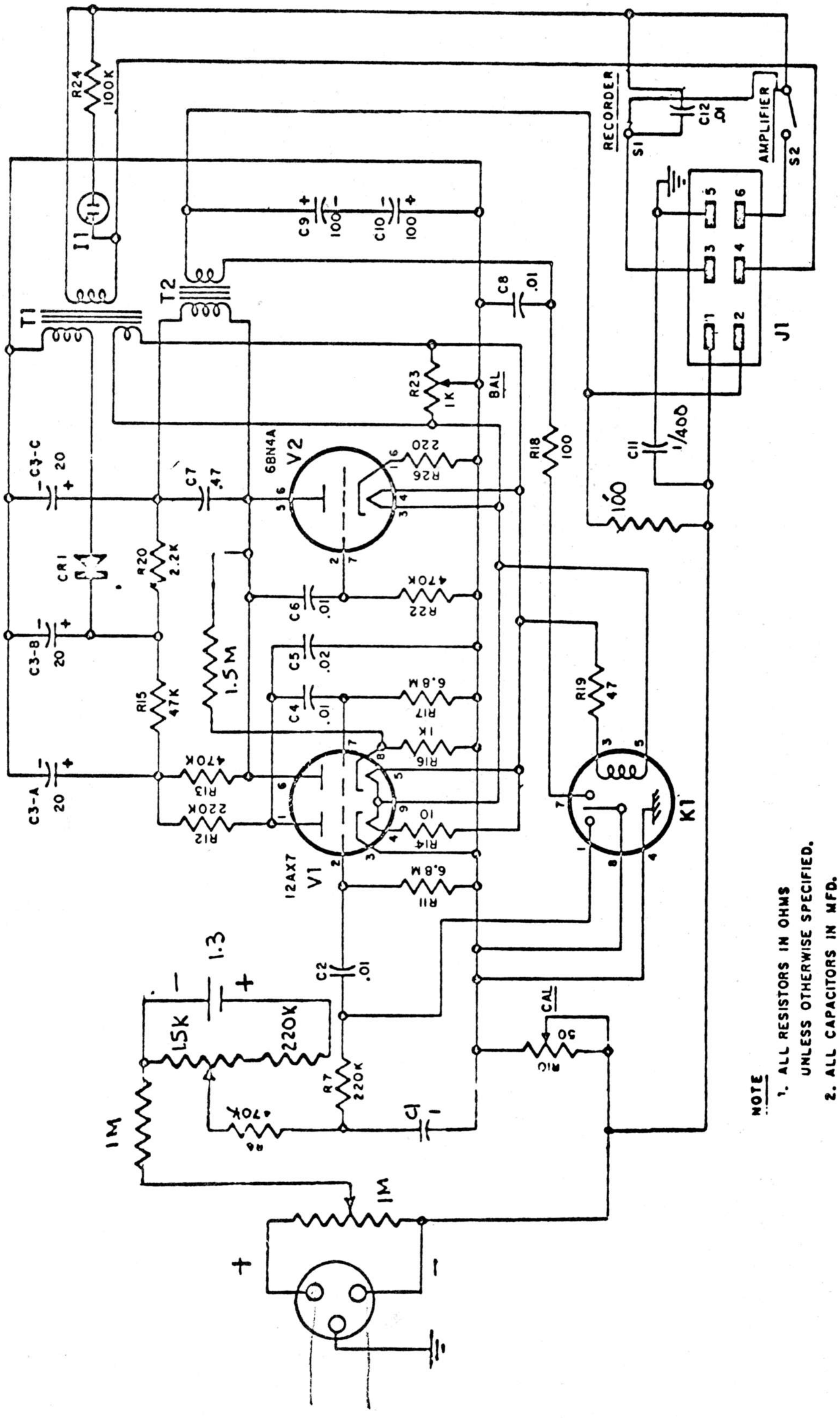
FIG. 3

AURAL & VISUAL PLATE VOLTAGE & CURRENT SAMPLING CIRCUITS



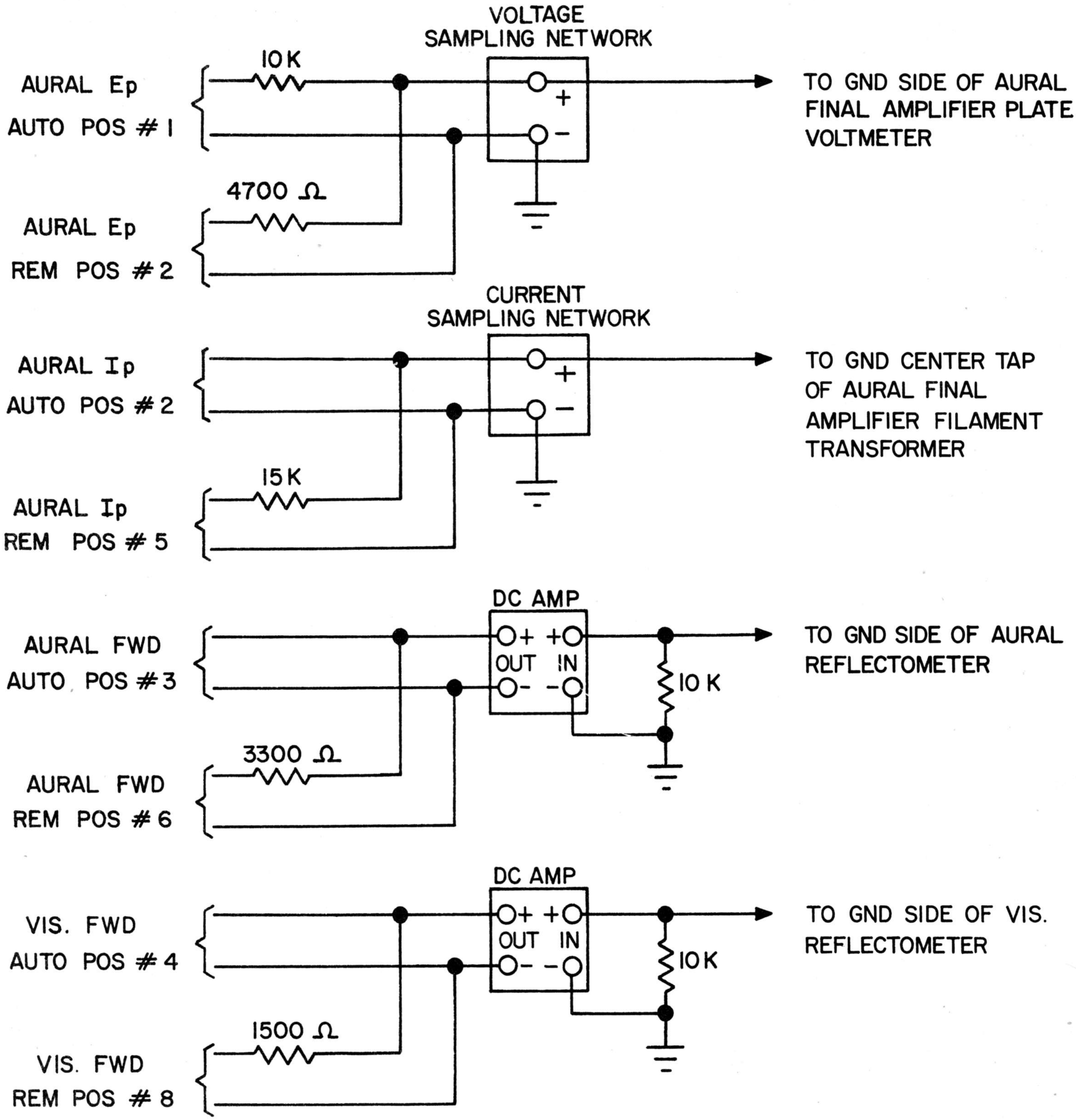
TO REMOTE
METERING SYSTEM

FIG. 4



D. C. AMPLIFIER

FIGURE 5



BLOCK DIAGRAM OF
MANUAL AND AUTOMATIC SAMPLING SYSTEM

FIG. 6

AUTOMATIC LOGGING SYSTEM

Introduction

The automatic logging equipment employed in the experiment tests at WABI-TV was the Rust AL-9 system which is shown in Figure 7. Inspection of this diagram shows that the unit shares the existing metering line of the remote control equipment and therefore needs no additional metallic circuitry between the studio (remote control point) and the transmitter. Although the control pair associated with the remote control system remains untouched so that "fail-safe" operation and remote control functions will not be disturbed. The fail-safe circuit was disabled during the test to prevent the accidental deactivation of the transmitter.

The automatic logger is designed to operate in conjunction with any existing DC remote-control equipment without modification. The logger sequentially samples and records on dry pressure-sensitive paper as many as nine parameters. In addition, alarm facilities have been added to indicate when the readings deviate above or below the adjustable limits. These limit alarms can be incorporated in any, or all chart recorder positions.

Figure 8 is a photograph of the remote control and automatic logging system which was installed at the WABI-TV studios.

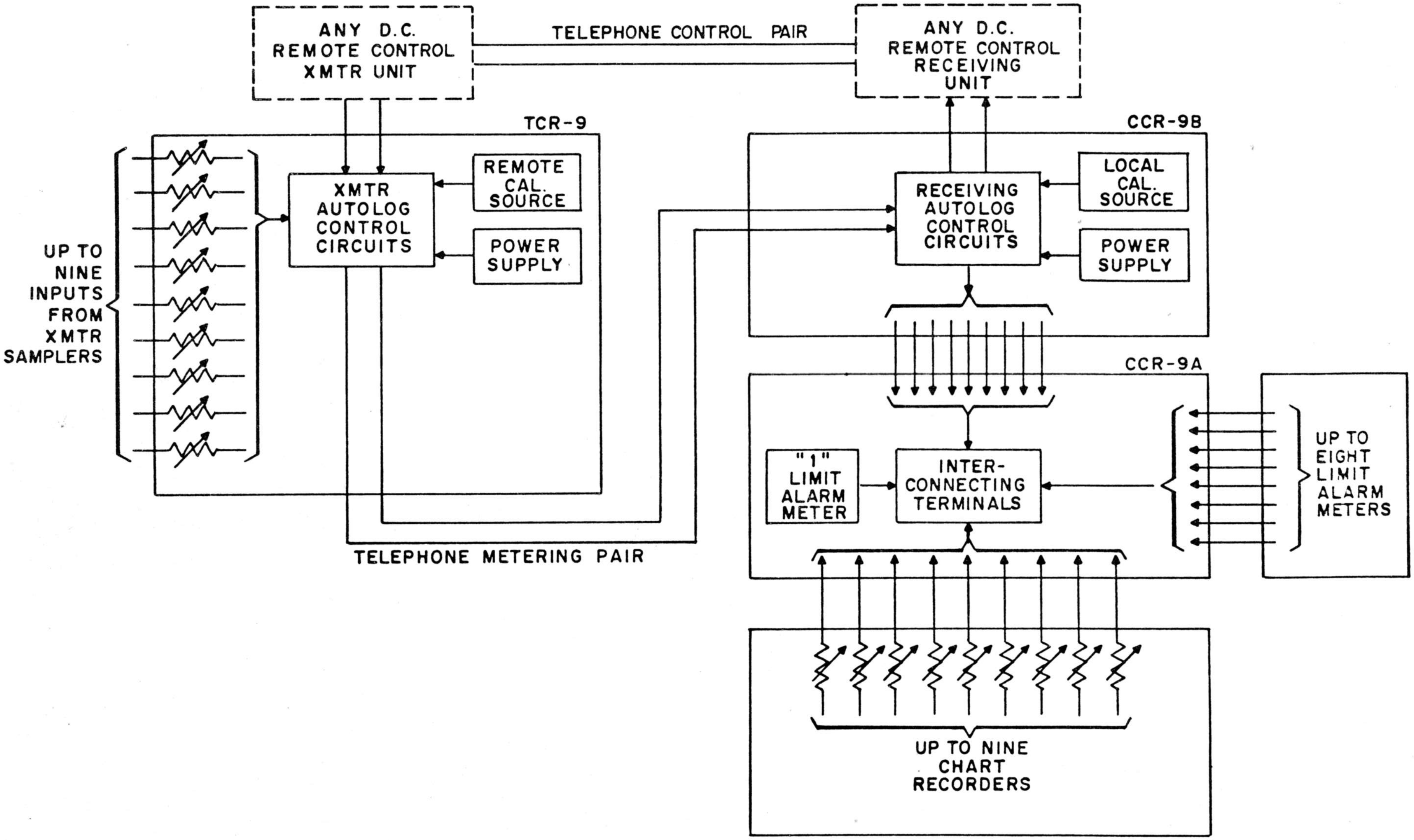


FIGURE 7.
BLOCK DIAGRAM, AL-9 AUTOMATIC TRANSMITTER LOGGER

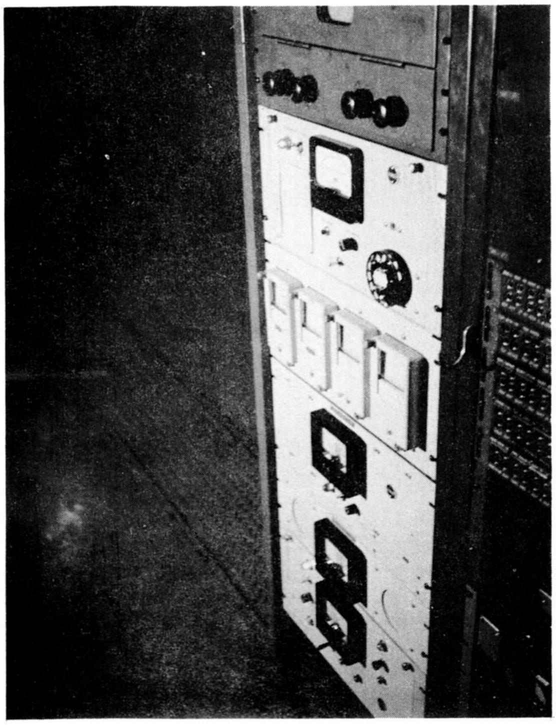


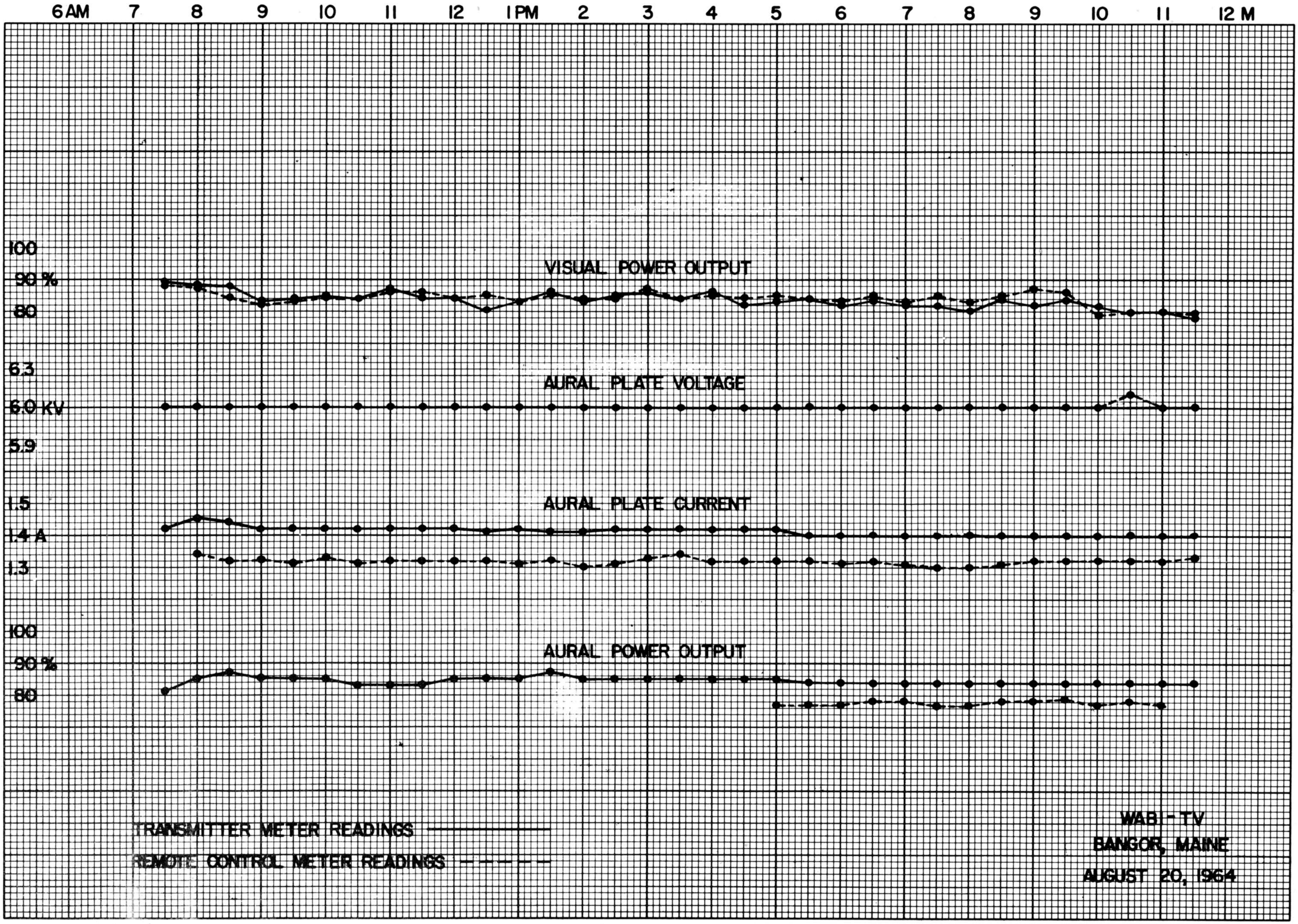
FIGURE 8

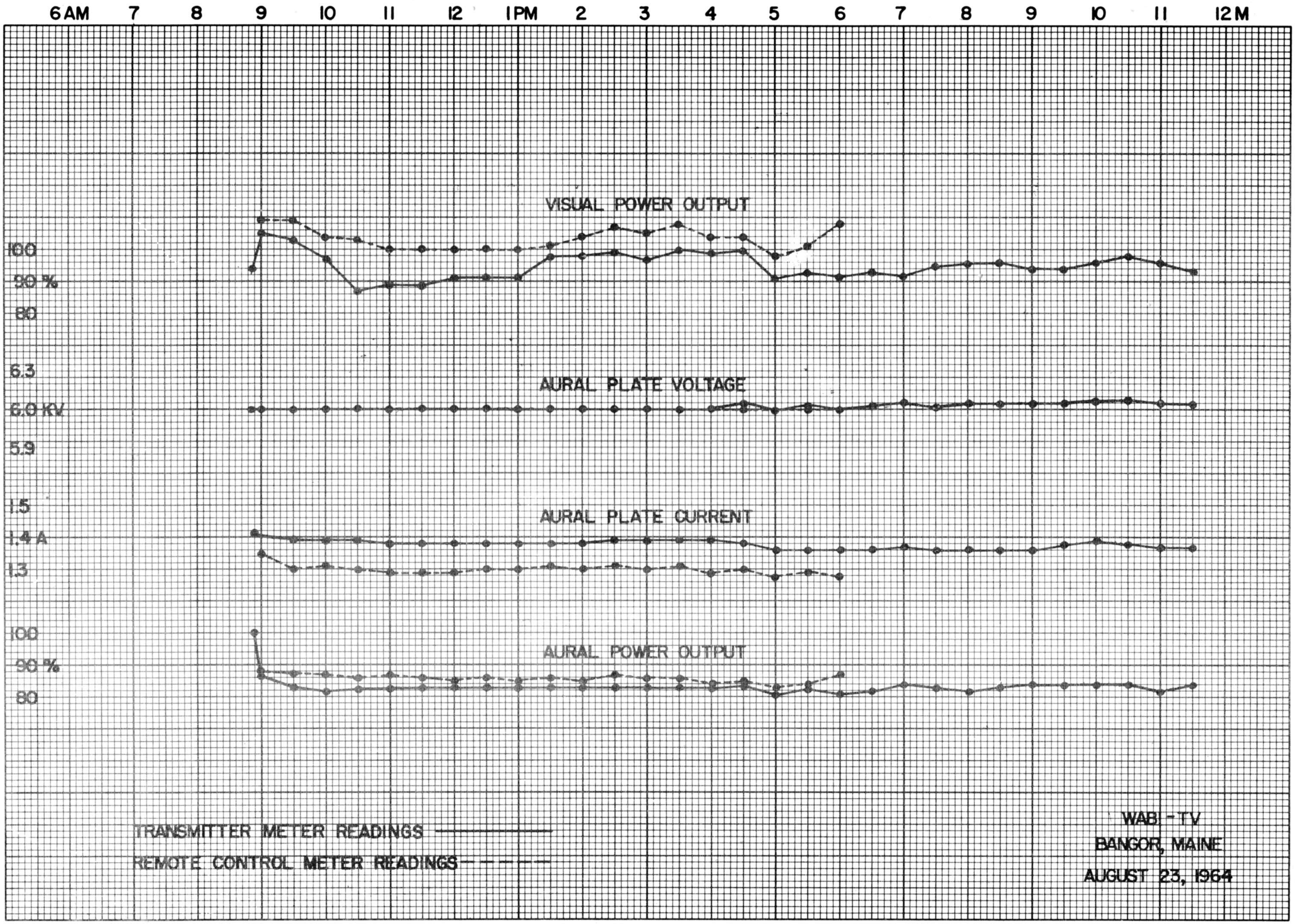
PHOTOGRAPH OF THE REMOTE CONTROL
AND AUTOMATIC LOGGING SYSTEM

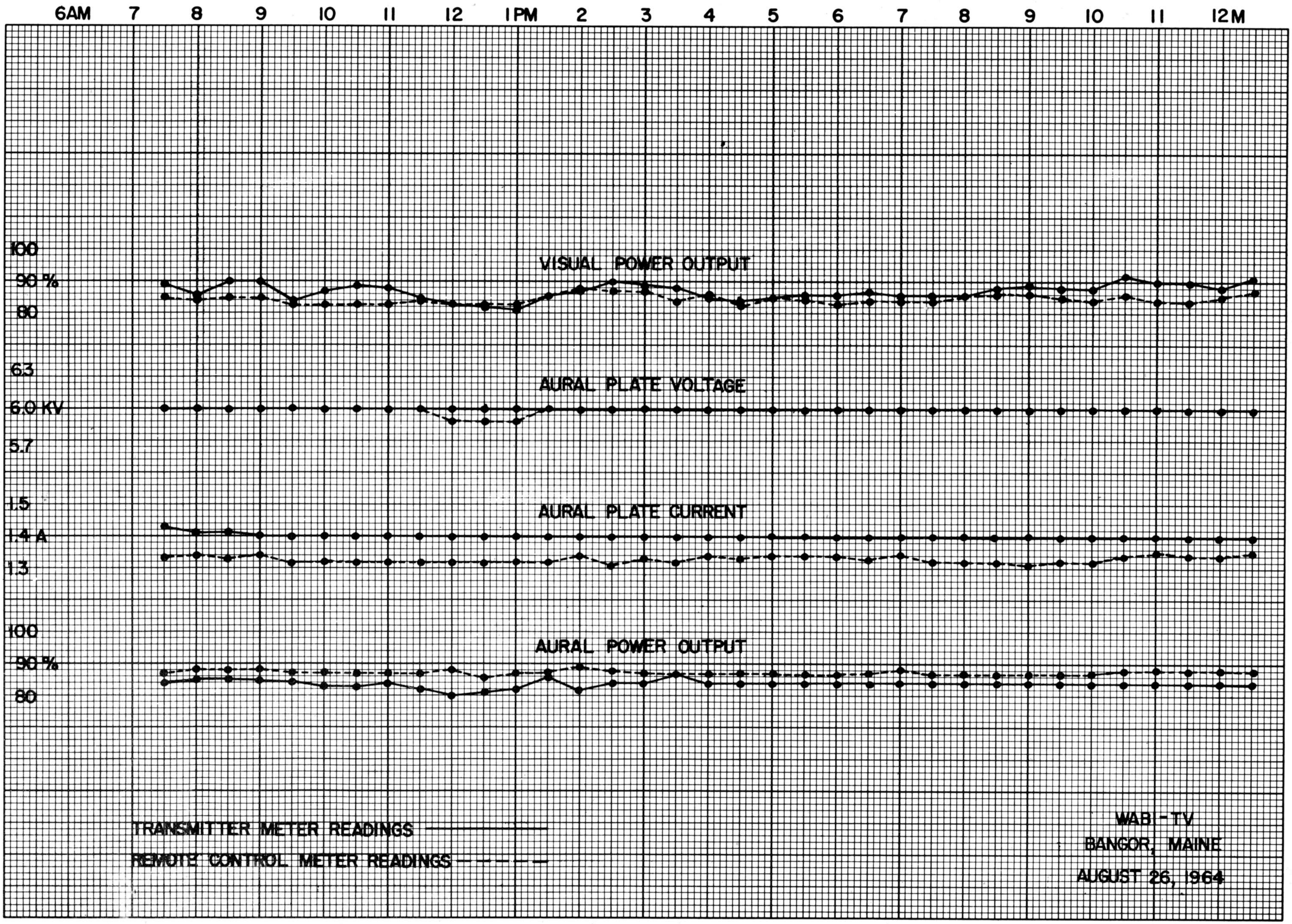
Metering Observations

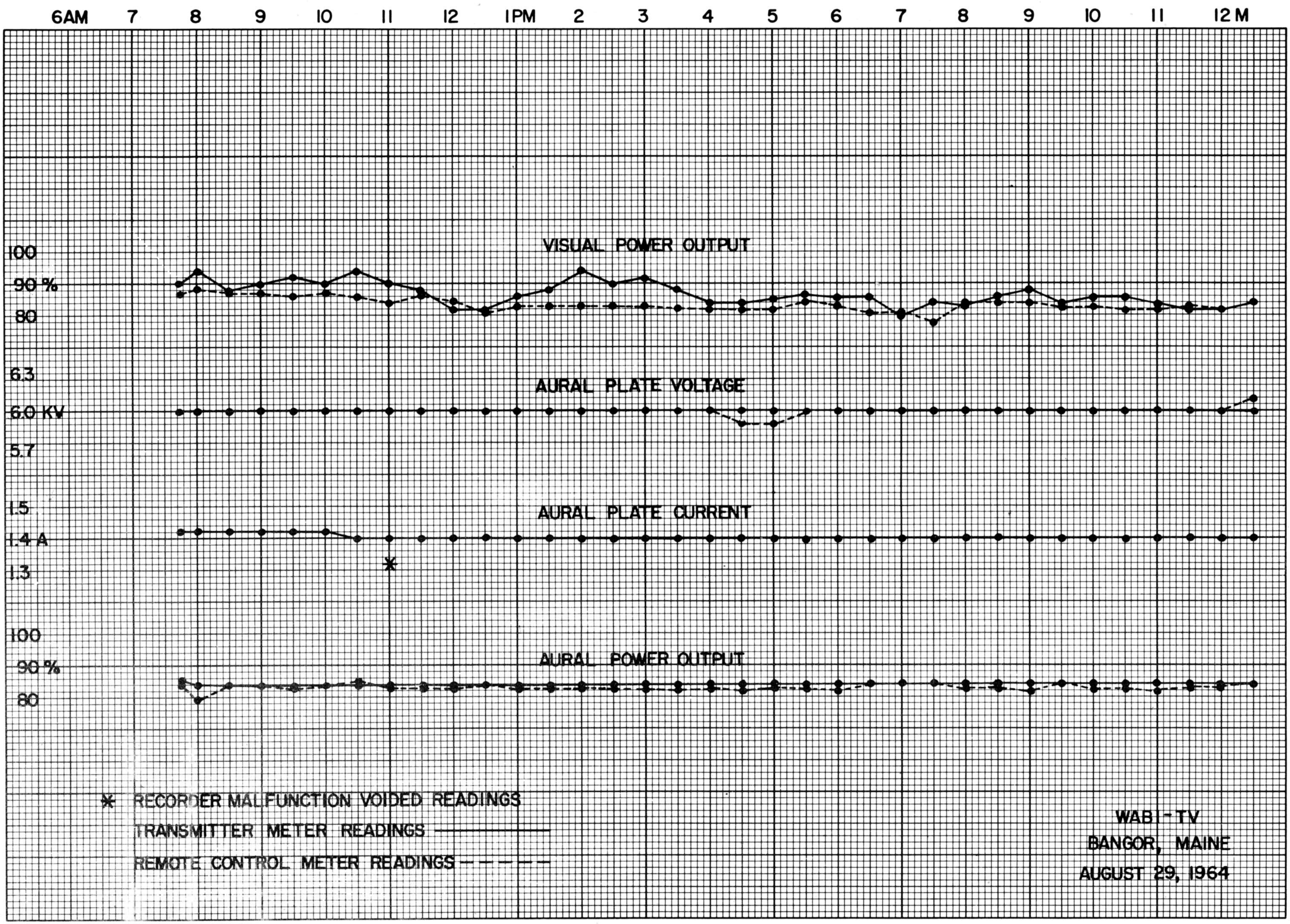
In the following graphs, the remote control readings are compared to the readings taken at the transmitter as recorded in the transmitter log. The graphs shown herein are a representative sampling of the data obtained during the course of the entire experiment.

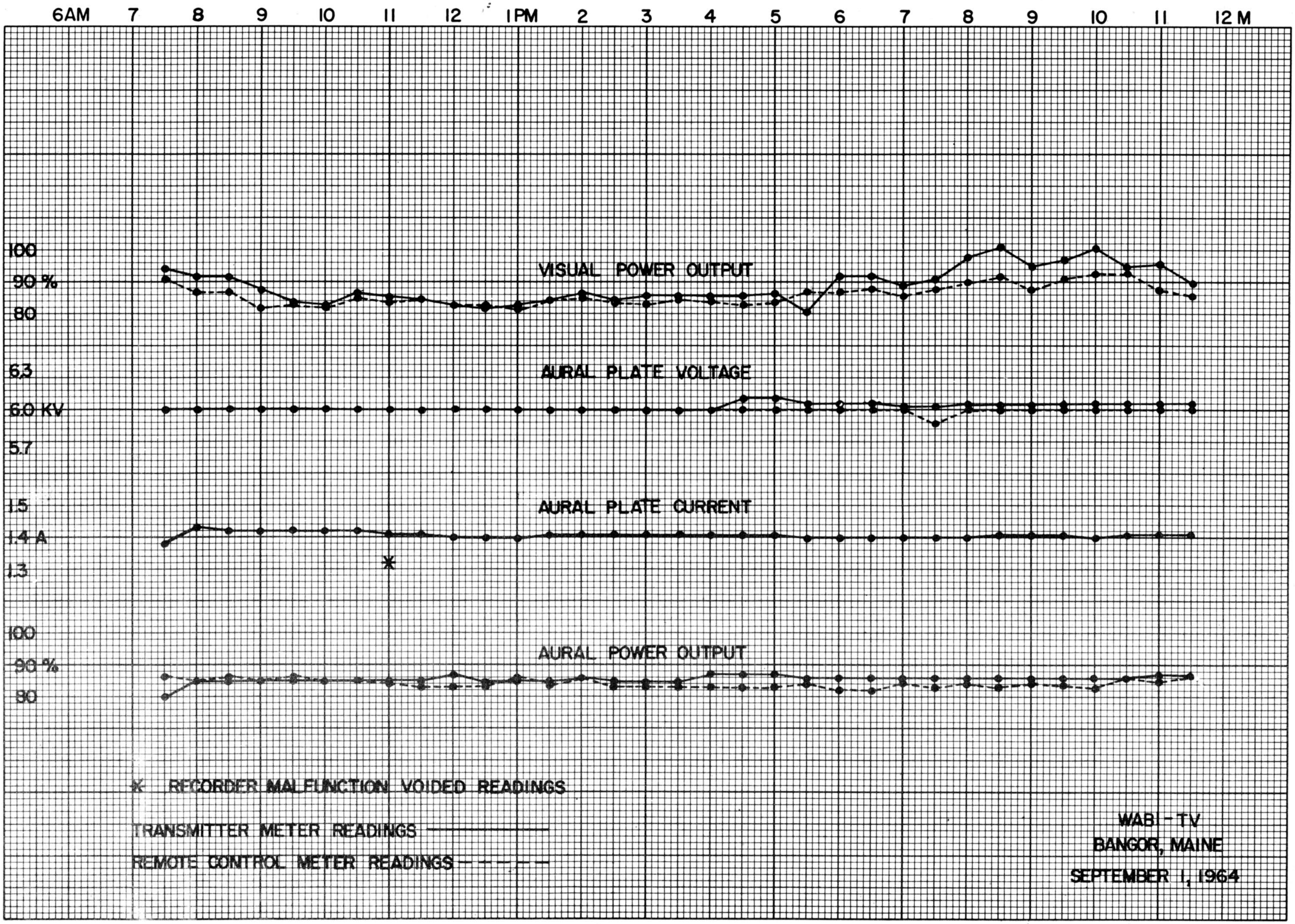
The meter readings depict visual and aural power output, aural plate voltage and aural plate current. The metered parameters fulfill the minimum logging requirements for television broadcast transmitters as specified in Section 73.671 of the Commission's Rules.

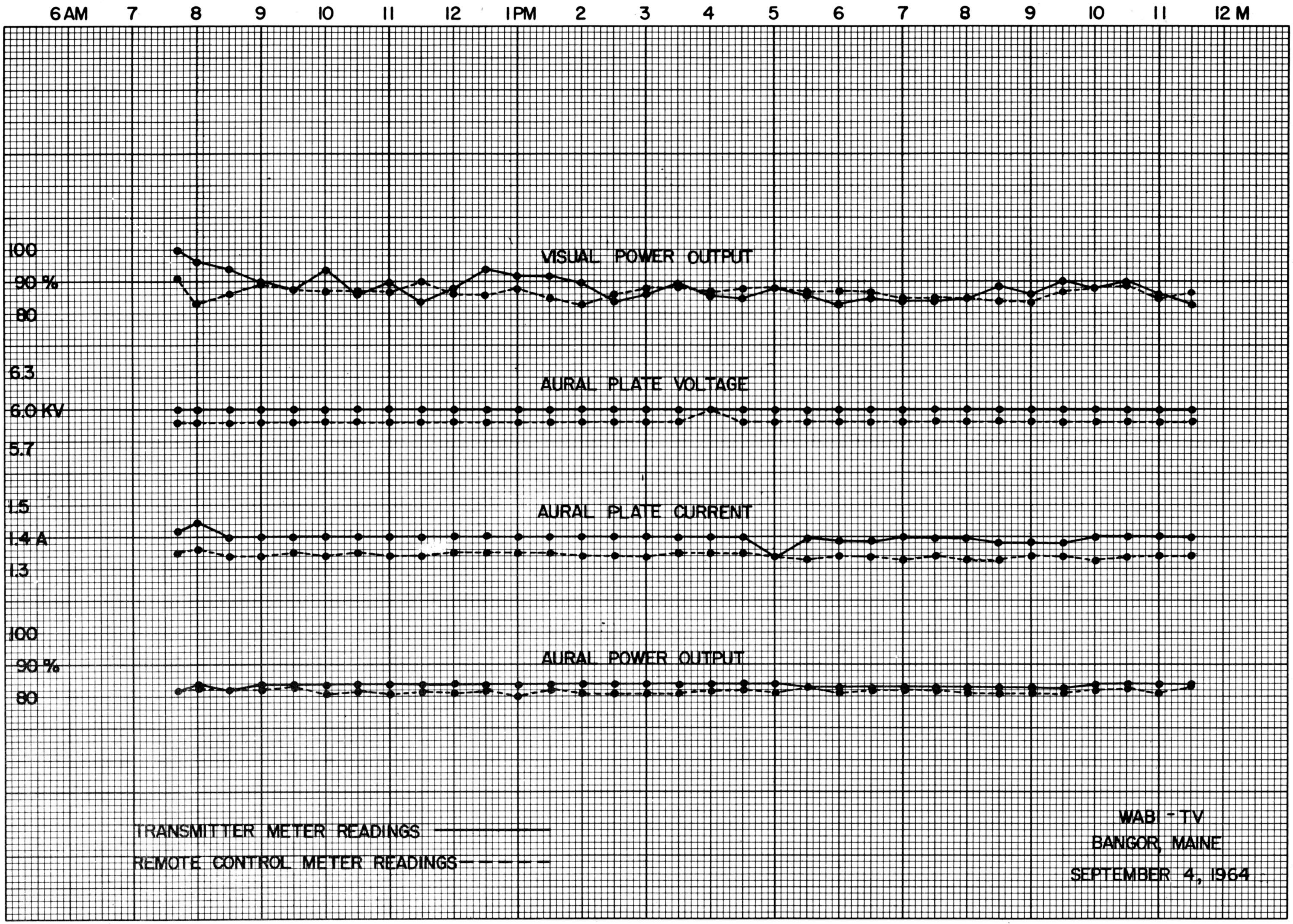

6 AM
7
8
9
10
11
12
1 PM
2
3
4
5
6
7
8
9
10
11
12 M
100
90 %
80
VISUAL POWER OUTPUT
6.3
6.0 KV
5.9
AURAL PLATE VOLTAGE
1.5
1.4 A
1.3
AURAL PLATE CURRENT
100
90 %
80
AURAL POWER OUTPUT
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
AUGUST 20, 1964

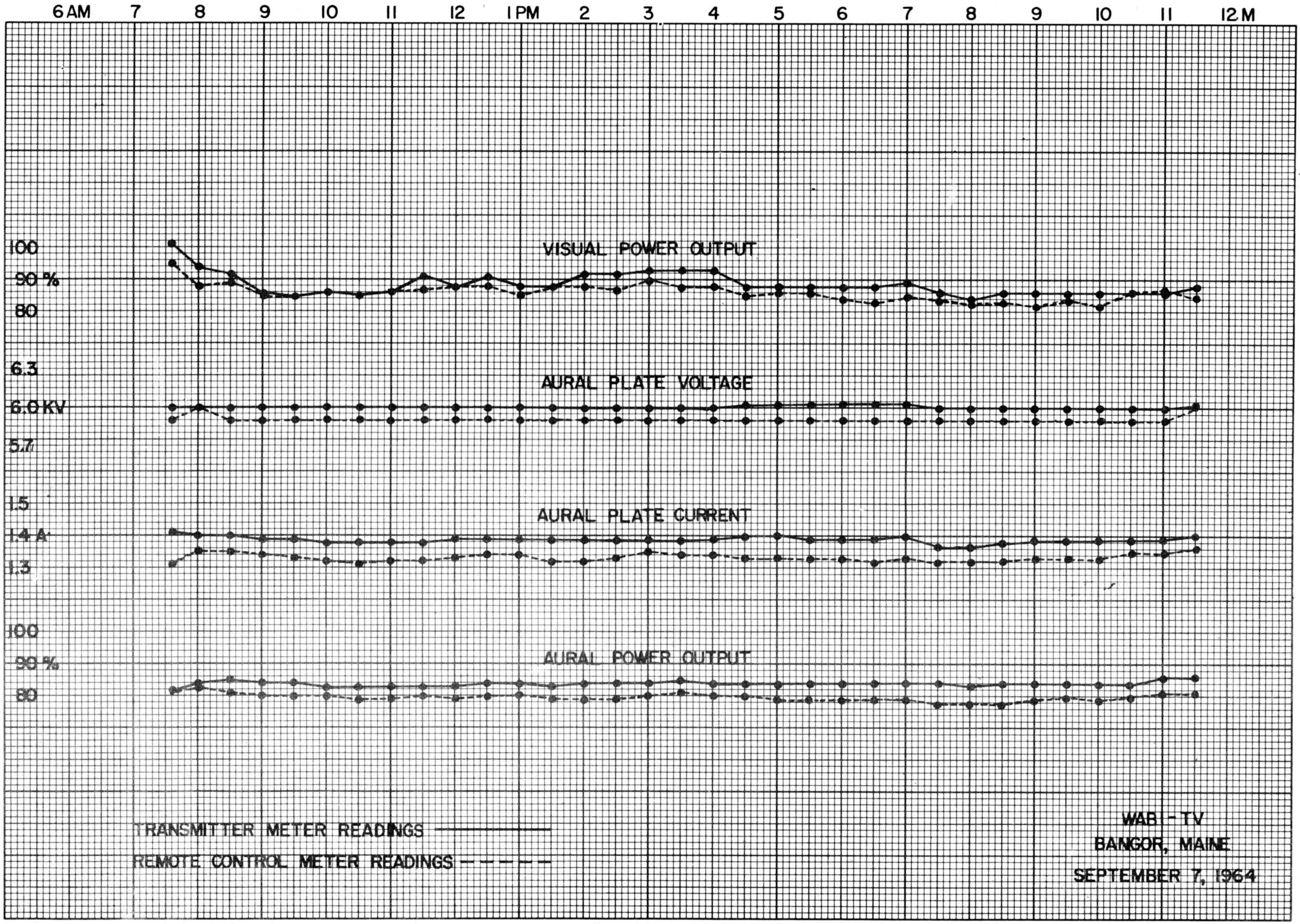

6 AM
7
8
9
10
11
12
1 PM
2
3
4
5
6
7
8
9
10
11
12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.9
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
AUGUST 23, 1964

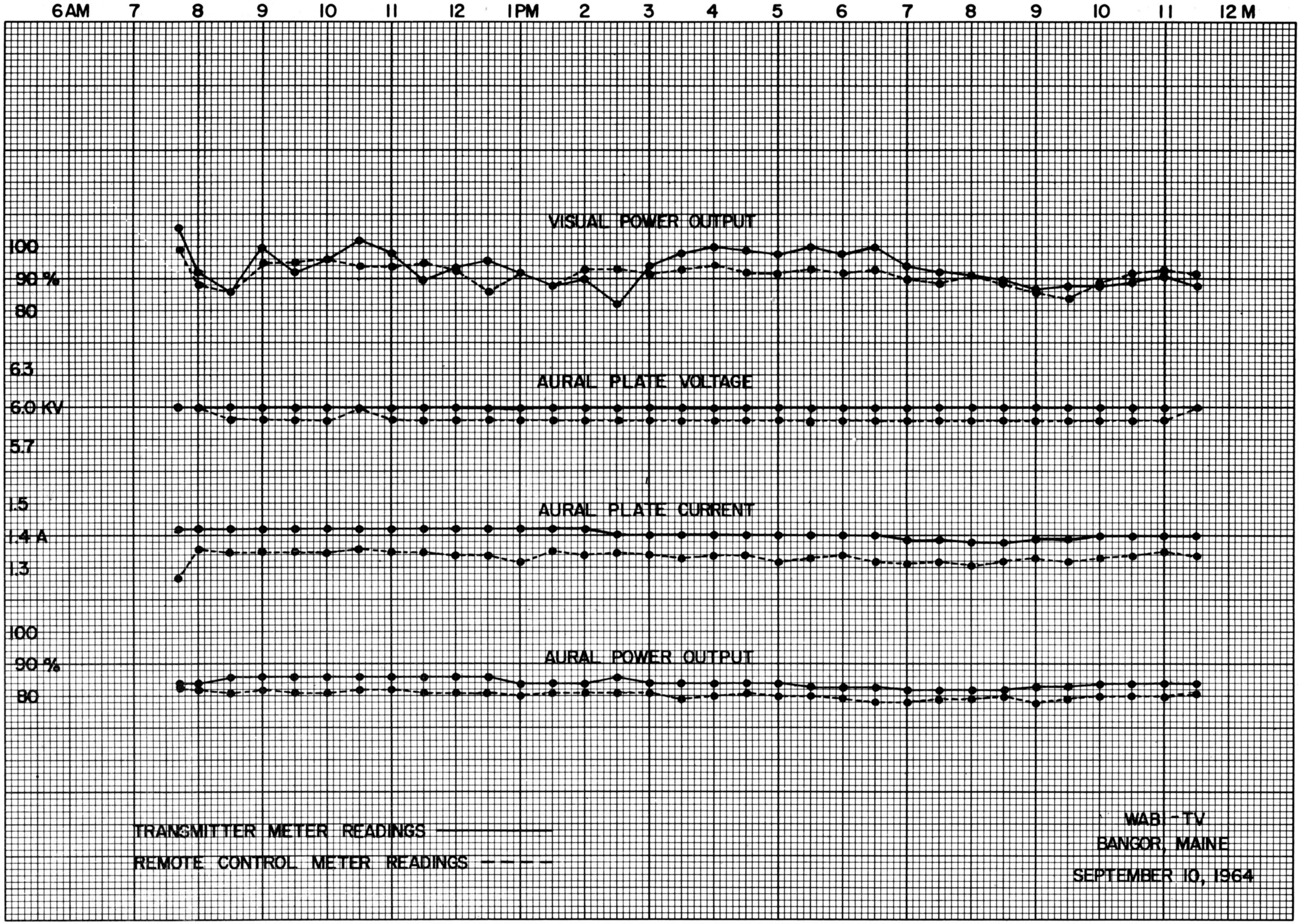

6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12M
100
90 %
80
VISUAL POWER OUTPUT
6.3
6.0 KV
5.7
AURAL PLATE VOLTAGE
1.5
1.4 A
1.3
AURAL PLATE CURRENT
100
90 %
80
AURAL POWER OUTPUT
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
AUGUST 26, 1964

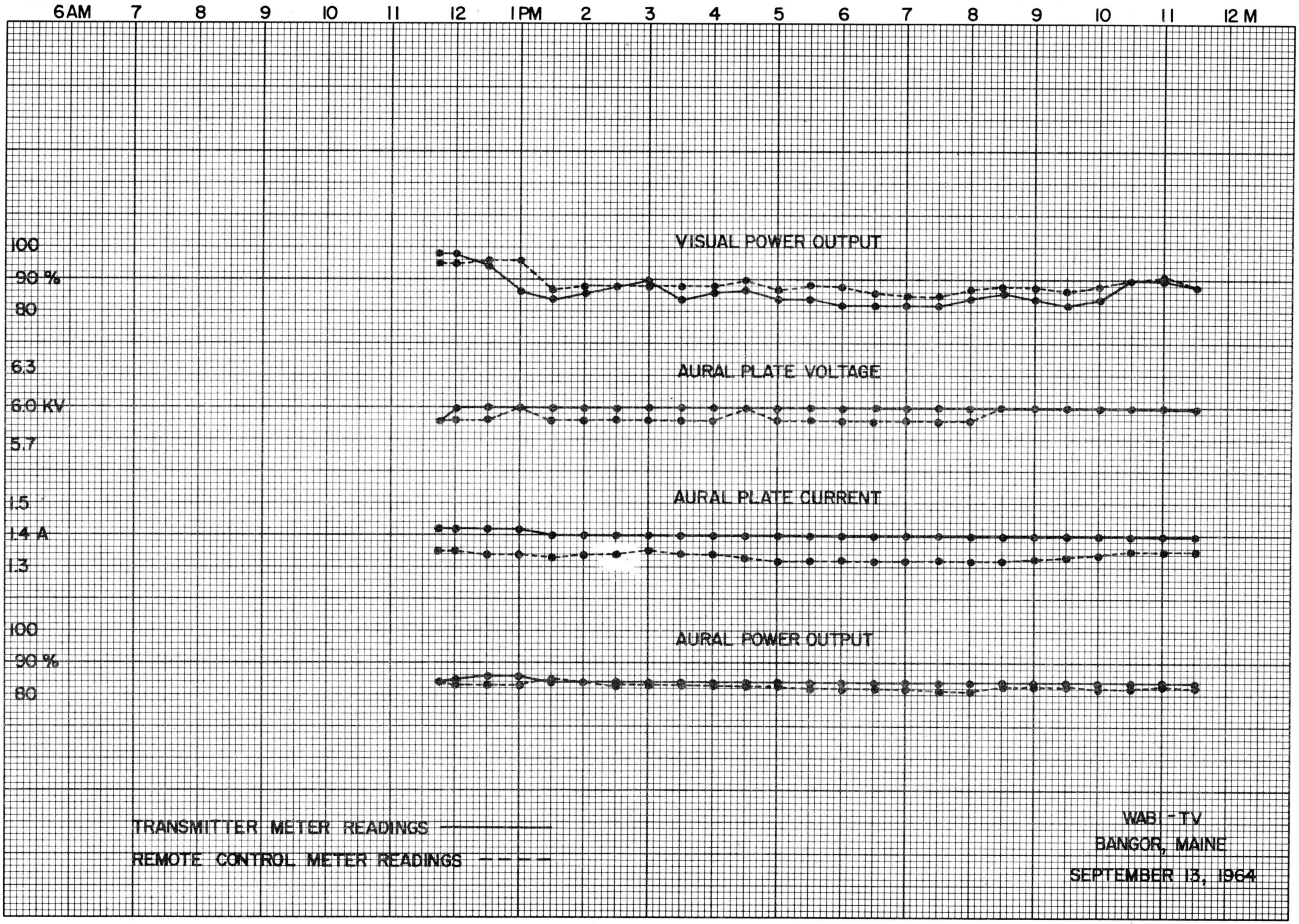

6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.7
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
* RECORDER MALFUNCTION VOIDED READINGS
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI-TV
BANGOR, MAINE
AUGUST 29, 1964


6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12 M
100
90 %
80
VISUAL POWER OUTPUT
6.3
6.0 KV
5.7
AURAL PLATE VOLTAGE
1.5
1.4 A
1.3
AURAL PLATE CURRENT
100
90 %
80
AURAL POWER OUTPUT
* RECORDER MALFUNCTION VOIDED READINGS
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
SEPTEMBER 1, 1964

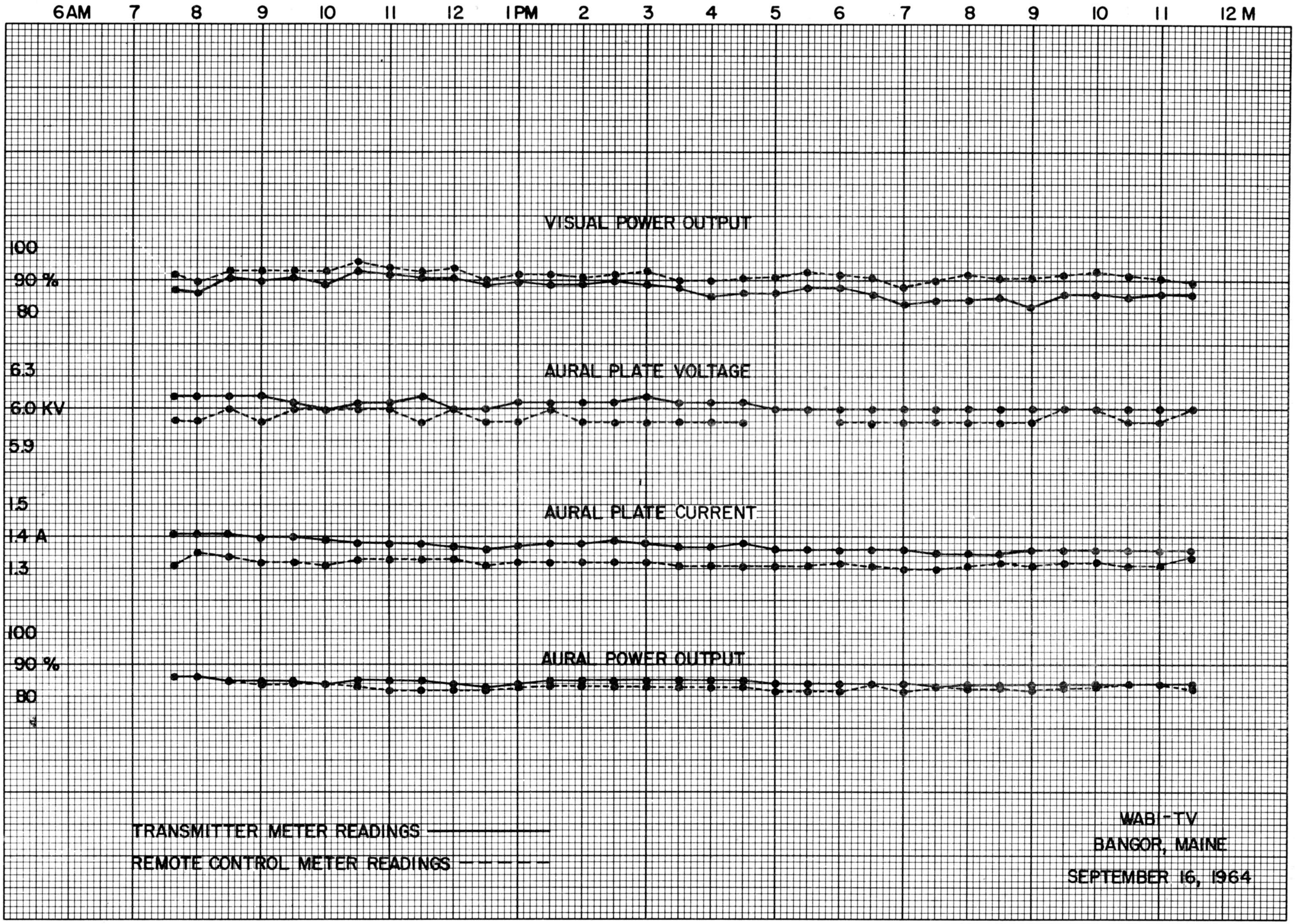

6 AM 7 8 9 10 11 12 1 PM 2 3 4 5 6 7 8 9 10 11 12 M
100
90 %
80
VISUAL POWER OUTPUT
6.3
6.0 KV
5.7
AURAL PLATE VOLTAGE
1.5
1.4 A
1.3
AURAL PLATE CURRENT
100
90 %
80
AURAL POWER OUTPUT
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
SEPTEMBER 4, 1964


6 AM 7 8 9 10 11 12 1 PM 2 3 4 5 6 7 8 9 10 11 12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.7
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
SEPTEMBER 7, 1964


6 AM
7
8
9
10
11
12
1 PM
2
3
4
5
6
7
8
9
10
11
12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.7
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
SEPTEMBER 10, 1964



6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.7
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI - TV
BANGOR, MAINE
SEPTEMBER 13, 1964


6AM 7 8 9 10 11 12 1PM 2 3 4 5 6 7 8 9 10 11 12 M
VISUAL POWER OUTPUT
100
90 %
80
AURAL PLATE VOLTAGE
6.3
6.0 KV
5.9
AURAL PLATE CURRENT
1.5
1.4 A
1.3
AURAL POWER OUTPUT
100
90 %
80
TRANSMITTER METER READINGS
REMOTE CONTROL METER READINGS
WABI-TV
BANGOR, MAINE
SEPTEMBER 16, 1964

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SUMMARY RESULTS OF WABI-TV REMOTE CONTROL EXPERIMENT

As stated previously, this portion of the experiment was designed to test the feasibility of remotely controlling and metering a large VHF-TV transmitter using an existing wireline control system. Due to limitations imposed on the test because of transmitter design, it was not considered practical to extend the control functions to other important circuits for the purposes of this experiment.

Although the control was somewhat limited in scope, the remote metering and logging test was considered extremely successful. There were no significant metering malfunctions during the test and no degradation of the transmitter signals occurred.